THE Petroleum Engineer • AUGUST 1934 • VOLUME V • NUMBER XII

THE ENGINEERING MAGAZINE OF THE OIL AND GAS INDUSTRY

This Issue Contains

DRILLING AND PRODUCTION

	Page
Drake—The Discoverer	22
Oilfield Development Methods and Equipment Since 1859 — By K. C. Sclater	24
Glimpses of Petroleum Pioneering Days — By Harry Botsford	27
Cementing Off Intervening Water-Bearing Strata in Pay Horizons — By Wallace A. Sawdon	33
Light Translucency of Thin Adsorbed Films of Lubricants — By S. Fischer, Jr., and Edward Marinoff	36
Elements of Applied Petroleum Production — By K. C. Sclater	55
Applying Simple Physical Principles to Practical Problems — By W. C. Lane	83

REFINING AND NATURAL GASOLINE MANUFACTURE

A Graphical Solution of Data Obtained from the A.S.T.M. Method of Charcoal Residue Testing — By J. L. Thompson	43
Elements of Applied Petroleum Refining — By W. L. Nelson	58
The Control of Vapor Pressure — By F. L. Kallam	82

OIL AND GAS TRANSPORTATION

New Methods Employed in Repairing Gas Line Laid in Bay — By Frank H. Love	30
Elements of Applied Petroleum Pipe Line Transportation — By Emory Kemler and L. L. Thomas	48
Wax Deposits in Pipe Lines — By M. T. Buford	78

REGULAR DEPARTMENTS

The Course of Oil	11
Highlights in Oildom	12
Latest Activities in the Oil Fields	14 and 15
Progress of Major Pipe Line Work	16
The Month's Activities in Refining	13
Laugh with Barney	66
New Petroleum Equipment	68, 70, 71 and 72
Running Tour with Men in the Industry	75 and 76
Strange But True	80

Beginning This Issue

Series of articles on Elements of Applied Petroleum Pipe Line Transportation. See page 48, Engineering Fundamentals Department.

Meetings

Drake Well Memorial Celebration — August 24, 25, 26 and 27, Titusville, Pennsylvania.

•

American Chemical Society — September 10, 11, 12, 13 and 14, Cleveland, Ohio.

•

American Institute of Mining and Metallurgical Engineers, Petroleum Division, Fall Meeting—October 12 and 13, Mayo Hotel, Tulsa, Oklahoma.

•

American Gas Association, Convention and Exhibition—October 29, Atlantic City, New Jersey.

•

American Petroleum Institute, Fifteenth Annual Meeting—November 12, 13, 14 and 15, Dallas, Texas.

•

National Exposition of Power and Mechanical Engineering—December 3, 4, 5, 6, 7 and 8, Grand Central Palace, New York City.

•

Society of Automotive Engineers, Annual Dinner—January 7, New York City.

THE PETROLEUM ENGINEER PUBLISHING COMPANY

Tower Petroleum Building :: Dallas, Texas

C. Morris - - - - - *President-General Manager*
J. L. Dwyer - - - - - - - - *Vice-President*
T. J. Crowley - - - - - - - *Vice-President*
W. T. Bryan - - - - - - *Secretary-Treasurer*
W. L. Love - - - - - - *Advertising Manager*
C. R. Barrett - - - - - - *Circulation Manager*
K. C. Sclater - - - - - - - - - *Editor*
Frank H. Love - - - - - - *Associate Editor*

COPYRIGHT—Each issue of The Petroleum Engineer is copyrighted. Any republication of the matter appearing in the magazine, either wholly or in part, is not permitted except by special authorization. SUBSCRIPTION PRICE *—Single copies 15 cents. Domestic and foreign, $1.00 per year, three years $2.00, with the exception of Canada, where the price is $1.65 per year, three years $3.95.*

MEMBER A. B. C.

NRA MEMBER U.S. WE DO OUR PART

MEMBER A. B. P.

The men on Dalhart No. 1: The man at the right wearing a white hat is W. D. Casebolt, head driller. At the left of him is L. B. Nichols, representative of the Hinderliter Tool Co. Others, including man at the extreme right only partly on picture are: Cal Weaver, driller; J. R. Sturn, driller; G. L. Jones, tool dresser; C. J. Lattin, tool dresser; Bill Brining, tool dresser, and Jim Linden, truck driver.

"One Hundred and Fifty Actual Working Days . . . and Still Going Strong"

This is the record of a 1-inch x 5500-ft. Leschen "California Special" Cable-Tool Drilling Line on the Eben D. Warner Well "Dalhart No. 1," near Dalhart, Texas.

And here is what W. D. (Doc.) Casebolt, head driller, had to say about this line:

> "We put the line on the 5th day of December, and figuring shut-down time, it has actually operated 150 full working days and it looks as if it could go for another 150 days. I have never seen anything to equal it and I have been handling drilling lines for many years. We have encountered some of the hardest drilling in this part of the country and the way the line has stood up is remarkable."

In addition to this drilling line, Mr. Warner also has on this well a Leschen 5/8-inch x 5500-ft. Sand Line, and an 1 1/8-inch x 1100-ft. 6 x 19 Leschen Cast Steel Casing Line, which have given equally good service—all of which emphasises our often repeated statement, "The Service Record of Leschen Wire Lines Continues to Make and Hold Friends."

Made Only by A. Leschen & Sons Rope Co. Established 1857

ST. LOUIS—5909 Kennerly Avenue

New York . . . . . 90 West Street
Chicago . 810 West Washington Blvd.
Denver . . . . . 1554 Wazee Street
San Francisco . . 520 Fourth Street

Domestic Distributors:

CASEY & NEWTON
901 Century Building, Pittsburgh, Pa.
HILLMAN-KELLEY, *Incorporated*
2441 Hunter Street, Los Angeles, Calif.
HINDERLITER TOOL COMPANY
Tulsa, Okla.
NORVELL-WILDER SUPPLY COMPANY
Beaumont, Texas
OSBORN MACHINERY COMPANY, *Inc.*
Clarksburg, W. Va.
PARKERSBURG SUPPLY COMPANY
Parkersburg, W. Va.
UNION PIPE AND SUPPLY COMPANY, *Inc.*
Owensboro, Kentucky
UNITED PIPE AND SUPPLY CORPORATION
Charleston, W. Va.

Export Distributor:

CONTINENTAL EMSCO CO., Inc., 19 Rector St., New York, N. Y.
Branches: Buenos Aires — London — Ploesti

The Course of Oil

By K. C. SCLATER

Petroleum's Diamond Jubilee

This month a memorable event will be fittingly celebrated at Titusville, Pennsylvania. On the twenty-seventh day of August the petroleum industry as we know it today will be seventy-five years old. Elaborate plans have been made to commemorate this anniversary, and include a four-day round of activities appropriate to the occasion, culminating in the formal dedication on Monday, the twenty-seventh, of the Drake Well Memorial Park, where, seventy-five years ago, Edwin L. Drake brought in the first commercially productive oil well in the United States and thereby founded an industry.

The expansion of the petroleum industry to its present size in the short span of seventy-five years is unique in the history of industrial enterprise. Less than a hundred years ago the value of petroleum as a natural resource was practically unknown. Today it is one of the most indispensable commodities of modern civilization. Life today without petroleum would be difficult to imagine. Without it motor transportation might not yet have progressed far beyond the horse-and-buggy days; air transportation might still be a dream of the remote future. To understand why and how this growth took place, we must hark back to early petroleum pioneering days. Those days tell a great story. The momentum then gathered in the incessant hunt for new oil pools has not slackened to this day.

Petroleum has been known to man for centuries, and its use recorded even as far back as Biblical times, but its commercial exploitation was never undertaken on any extensive scale approaching that witnessed during the years immediately following the drilling of the Drake well in 1859. Up until then the widespread occurrence of petroleum in nature was recognized, but its natural abundance was only vaguely perceived. During the sixties, when oil began to be produced in large quantities from wells, the keen minds of those days were quick to realize the nature and distribution of this raw liquid product of nature. The vast possibilities fired their imagination. Prospecting by means of the drill soon grew in intensity; the wildcatting fever would rise to new heights with each oil discovery. Excitement would subside for a while, only to flare up anew with the bringing in of another wildcat. Expansion of oil operations was of the most proliferous type imaginable, and lacked any semblance of coordination.

Under such conditions, a glut of oil on the market, followed by a slump in prices, was of frequent occurrence. But the consumption of petroleum continued to grow apace. It was in good demand for foreign export. New uses for petroleum were constantly being found. Refining practices were undergoing improvement and new products being placed on domestic markets. Improvements in drilling methods and machinery only served to hasten development and increase the ever-widening search for oil.

Under the impetus of all these factors the industry in the United States has continued to grow until at its present magnitude it represents a capital investment of more than twelve billion dollars. The depth of wells has increased enormously. Transportation facilities have been vastly extended and refining processes perfected to a point far surpassing what was ever thought possible. Since 1859 close on 850,000 wells have been drilled for oil or gas in the United States alone. Of these, about 350,000 are producing today. Many of the improvements in methods and equipment in the early days were expedients, made out of sheer necessity. Little heed was then given to the scientific aspects of oil production. It has been only within the last few years that the average oil producer has paid much attention to determining the best ways and means to drill for oil. In the deep-drilling of today, tremendous financial losses may easily be incurred by slipshod methods of operation. A hole must be reasonably close to the vertical. Casing must be securely set and all water properly shut off. The old seed-bag has been superseded by modern cementing methods. The Drake well was a few inches less than seventy feet deep; the deepest well today is 11,377 feet deep, thanks to modern hydraulic rotary drilling methods. A deep well may cost as much as $250,000; compare this with the cost of a few thousand dollars for a shallow well. What progress the industry has made must now be sought in terms of the average cost to produce a barrel of oil per foot of depth; the average cost per mile to transport a barrel of oil; and the average unit cost for fabricating refined petroleum products.

A network of pipe lines with modern pumping facilities now covers the country. Refineries with the most modern refining processes now dot the nation. Hundreds of drilling crews are engaged in sinking more wells. The wildcatter is still active in his search for new fields. All these facilities maintain and handle the two and a half million barrels of petroleum now required daily in this country. In the year following the drilling of the Drake well the daily production did not exceed a few hundred barrels a month.

And all this has come about in seventy-five years.

California May Invite A. P. I. 1935 Meeting

We have just been informed that the California Oil and Gas Association is planning to extend an invitation to the American Petroleum Institute to hold its 1935 meeting in Los Angeles, a movement which The Petroleum Engineer heartily endorses.

Eight years have elapsed since the convention last was held there and, being one of the three largest oil-producing states, California deserves regular recognition by the Institute. Many Californians have been unable to attend meetings held in Chicago, Houston and elsewhere and desire an opportunity again to take an active part in the work.

Furthermore, members of the A. P. I. from other parts of the United States, especially the engineers, superintendents and field men, will derive much benefit if the 1935 meeting is held in California. That state has always been one of the most progressive, having contributed many important methods and devices for the producing, refining and transportation of petroleum.

The only possible disadvantage of California as the convention state is its remote location from many oil centers. But a check of railroad and airway rates reveals that the cost of traveling from a majority of oil states to California is but slightly higher than to Chicago, where most of the meetings have been held. So far as traveling time is concerned, present-day schedules on both railroads and airplanes makes possible amazingly quick arrival in California from any place in the United States.

But any disadvantages that might be advanced are offset by Los Angeles' excellent facilities for handling the convention, the progressiveness of California oil men and, of course, the climate.

« « « HIGHLIGHTS IN OILDOM » » »

Appeals Court Upholds Refinery Bill

The Third Court of Civil Appeals at Austin, Texas, has handed down a decision upholding the constitutionality of House Bill No. 99, passed at the last called session of the Texas Legislature, giving the Railroad Commission regulatory powers over oil refineries. The Travis County District Court's decision, refusing to enjoin the commission from enforcing the law, was affirmed. The injunction was sought by George L. Culver, purchaser and refiner in the East Texas field, and others, who asserted it violated the search and seizure provisions of the Constitution.

In making its decision the Appellate Court said: "The Legislature, under the police power of the state, has the authority to regulate the refinery business, it being a part of the petroleum industry of this state, and within the scope and purview of the conservation laws of this state. In interpreting the act to determine whether it confers arbitrary and unreasonable power, it must be considered in the light of the broader powers exercised by the commission in the regulation of the petroleum industry under the conservation laws."

Associate Justice M. B. Blair wrote the opinion.

●

Natural Gasoline Manufacturers Must Submit Reports

An order announced by Secretary Harold Ickes, oil administrator, makes it compulsory for producers and manufacturers of natural gasoline to submit monthly reports to the oil administration. The reports will be made out according to a new form issued by the Petroleum Administrative Board that calls for more detailed information as to shipments than was required on a form previously used by the Bureau of Mines.

The Bureau of Mines has advised the Petroleum Administrative Board and Secretary Ickes that obtaining more detailed reports from manufacturers of natural gasoline will assist in gauging consumptive demand for gasoline, the basis for the allocation of gasoline and crude oil production allowable. It is pointed out that information previously obtained failed to furnish sufficient data covering the consumption of natural gasoline other than at refineries.

The new form will be distributed by the Bureau of Mines.

●

Preparing Amendment to Oil Code

Members of the legal staff of the oil administration are preparing an amendment to the oil code authorizing the fixing of quotas for crude entering interstate and intrastate commerce so as to limit movement to domestic and export demand. The amendment is for the purpose of coping with the "hot" oil situation by preventing its access to markets and has been requested by the American Petroleum Institute and the oil industry's planning and coordination committee.

Although a few changes are expected, informed parties say the machinery for fixing quotas will be much the same as that contemplated under the Disney measure, which died in committee in the session of Congress recently adjourned. That legislation would have empowered Secretary Ickes to prescribe the quotas in line with total demand as determined by him, giving due consideration to: requirements of trade areas and the customary source of supply for them; changes and trends in respect to trade areas or sources of supply; state conservation laws and orders of state regulatory bodies for regulating oil output; the location, quantity and distribution of ownership of stored petroleum along with the situations and requirements of owners; physical and economic conditions of fields, pools, wells and leases; past, current and expected importation of petroleum and its products.

●

Texas' Sour Gas Law Upheld

The constitutionality of Texas' sour gas law, permitting the stripping of natural gas for its gasoline content, has been upheld by United States District Judge Thomas M. Kennerly of Houston. Judge Kennerly, in a recent decision, sustained motions of dismissal in six suits filed in Federal Court at Amarillo last spring attacking the constitutionality of the stripping law and the legality of processing gas for its gasoline content. He also held in his opinion that the Railroad Commission has authority to grant stripping permits.

The sour gas law permits the stripping of gas for its gasoline content in the Panhandle field and the disposal of the residue gas in any manner that the operator sees fit. At present the bulk of the residue gas is being vented to atmosphere, and many believe that this practice will rapidly deplete the field of its gas resources.

●

Court Order Stays Code Enforcement

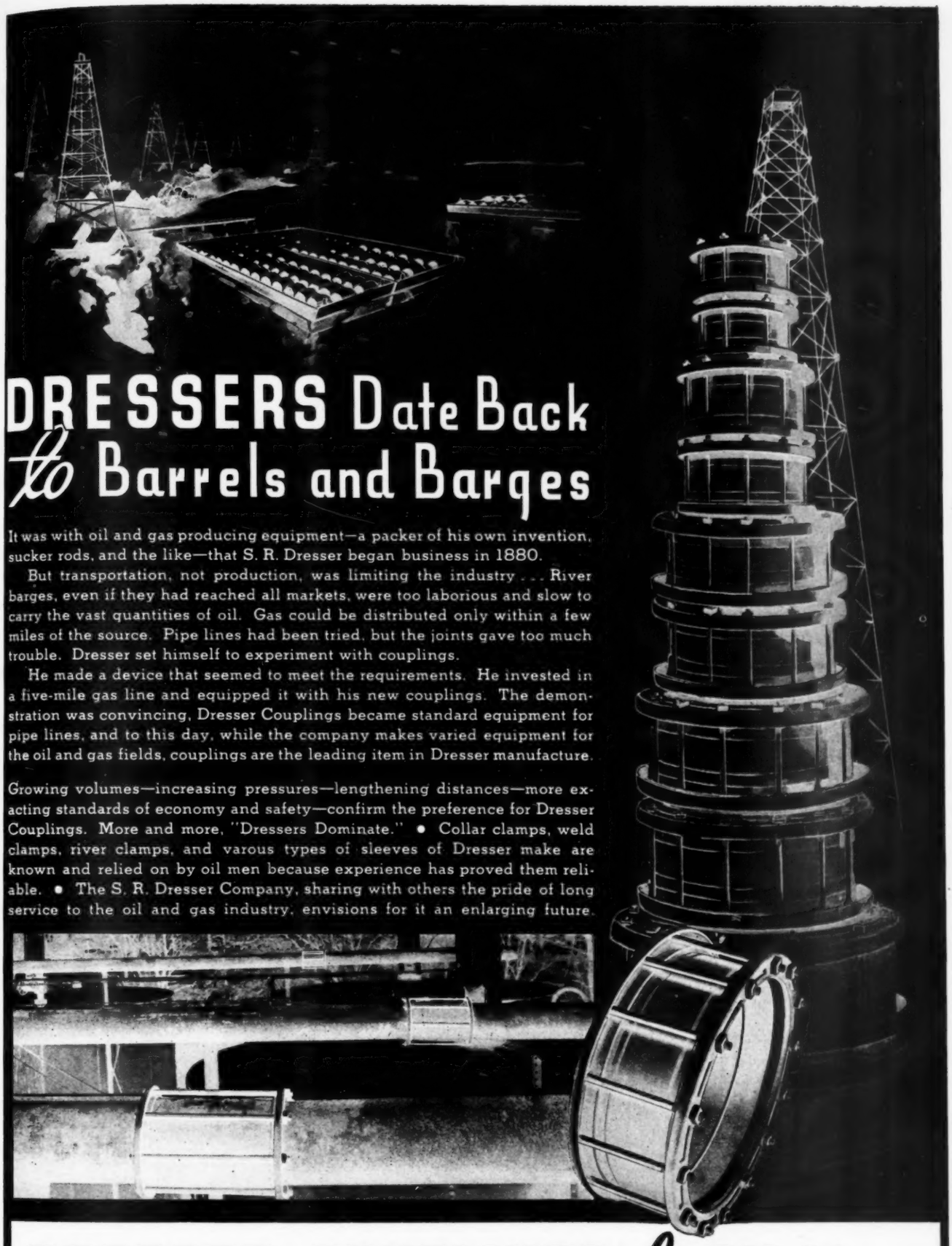
Provisions of the national petroleum code will not be enforced until a recent decision of the United States Fifth Circuit Court of Appeals at New Orleans, Louisiana, that upheld the government's right to regulate oil production, has been acted upon by the United States Supreme Court. When the Circuit Court handed down its decision recently in the Panama Refining Company's case an appeal was taken to the United States Supreme Court. An order was granted staying the court's mandate until such time as the Supreme Court has time to pass on the question (some time this fall). A counter move on the part of the government to have the staying order vacated was denied by the Circuit Court.

●

O. C. Wins First Round in Drilling Fight

Municipal officials of Oklahoma City won the first round in their court battle to prevent drilling for oil on a 100-acre tract northeast of the state capitol, when Federal Judge Franklin E. Kennamer at Oklahoma City denied a motion for a temporary restraining order. The motion was filed by the Inland Development Company, which brought the case to Federal Court after city authorities had refused permission to drill on five locations.

The land is within the 3000-ft. radius of the statehouse, in which zone drilling has been banned by executive order of Governor Murray.



DRESSERS Date Back to Barrels and Barges

It was with oil and gas producing equipment—a packer of his own invention, sucker rods, and the like—that S. R. Dresser began business in 1880.

But transportation, not production, was limiting the industry . . . River barges, even if they had reached all markets, were too laborious and slow to carry the vast quantities of oil. Gas could be distributed only within a few miles of the source. Pipe lines had been tried, but the joints gave too much trouble. Dresser set himself to experiment with couplings.

He made a device that seemed to meet the requirements. He invested in a five-mile gas line and equipped it with his new couplings. The demonstration was convincing, Dresser Couplings became standard equipment for pipe lines, and to this day, while the company makes varied equipment for the oil and gas fields, couplings are the leading item in Dresser manufacture.

Growing volumes—increasing pressures—lengthening distances—more exacting standards of economy and safety—confirm the preference for Dresser Couplings. More and more, "Dressers Dominate." • Collar clamps, weld clamps, river clamps, and varous types of sleeves of Dresser make are known and relied on by oil men because experience has proved them reliable. • The S. R. Dresser Company, sharing with others the pride of long service to the oil and gas industry, envisions for it an enlarging future.

DRESSER COUPLINGS for Oil Lines

S. R. DRESSER MANUFACTURING COMPANY • BRADFORD, PENNSYLVANIA

In Canada: Dresser Manufacturing Company, Ltd., 32 Front Street, W., Toronto, Ontario

LATEST ACTIVITIES IN THE OIL FIELDS

THE completion of two gusher wells in the Fitts pool of southern Pontotoc County, Oklahoma, is centering the attention of Oklahoma oil men upon that sector. Some are even looking upon it as possibly the most important oil development in the state since the opening of the Oklahoma City field in 1928. The wells that have caused such a wave of interest in the Fitts area are the first large producers for the field.

The J. C. Shaffer, W. A. Delaney, B. C. King and Sam Miller No. 1-A Harden, which found production in the Viola lime at 3672 ft., was drilled to a total depth of 4210 ft. and had an initial production at the rate of 200 bbl. per hour.

The J. E. Crosbie, Inc., No. 2 Harden had the pay sand from 4180 ft. to 4295 ft., was tubed and washed, and flowed 1453 bbl. of oil in 13 hours.

●

The Union Oil Company has proved a new producing area in Santa Barbara County, California, with the completion of its Moretti No. 1 at 2389 feet. On a pumping test the well made 30 to 75 bbl. daily of 16.8 gravity oil, cut four per cent. The new well is approximately one and a half miles south of the old Santa Maria field.

●

Another new oil producing area has been opened in Kansas as the result of the Lario Oil and Gas Company bringing in a well in the chat in Barber County, five miles northeast of Medicine Lodge. The wildcat test, No. 1 Frank Whelan, picked up the producing formation at 4355 ft., and was drilled to a total depth of 4428 feet. Eight-in. casing was set at 4345 ft., and after the plug was drilled the hole filled with oil to a depth of 3500 ft. in two hours and 15 minutes, then flowed over the crown block and settled to three-hour head flows.

●

The Davis, Denvers and Harrison No. 1 Lula S. George blew in a gasser on August 8, the first well in Hidalgo County, Texas, of commercial possibilities. Estimated production is from 50,000,000 to 75,000,000 cu. ft. daily. The well was drilled to 4136 ft. and showed for a gasser after several unsuccessful attempts at drill-stem tests had been made.

●

A new deep producer in the Cole field of Webb and Duval counties in Texas is believed by many to be the most important discovery in the Mirando area since the opening of the Government Wells field. The United Production Company's A. M. Bruni No. 2 was brought in with an initial flow of 45 bbl. per hour from producing sand at 3395-3422 feet. The oil tested 41.7 gravity. Production is said to be from the Yegua, a zone from which but a small amount of production has been developed in South Texas.

●

The first deep test in the West Mule Creek area of Wyoming has found oil. No. 1 Morell of the Inter-State Oil and Refining Company and the Fall River Royalty Company topped the Minnelusa at 2840 ft., at which depth 500 ft. of oil rose in the hole. The test is located three-quarters of a mile southwest of the shallow production in the West Mule Creek field.

●

Two recent completions in the Cut Bank field of Montana have proved up a heretofore doubtful area east of the town of Cut Bank. As a result lease requirements call for the drilling of at least 20 tests in the area within the next 90 days. R. C. Tarrant's No. 1 Jones found the producing sand at 2775-2787 ft., and was drilled to a total depth of 2795 feet. On the initial test the well made 250 bbl. daily. The Montana Power and Light Company's No. 1 Fuller had an initial production of 240 bbl. from sand at 2946-2965 ft., with the hole drilled to a total depth of 2969 feet.

●

Completion of the Old Dutch Oil and Gas Company's No. 1 Fargar, Montcalm County wildcat test, appears to have opened either a new Michigan gas field or what may prove to be an eight-mile extension of the Columbia Oil Company's wildcat gasser in Hinton Township in Mecosta County. The well was drilled to a depth of 1259 ft. and made 5,500,000 cu. ft. of gas on the initial test.

AVERAGE CRUDE OIL PRICES

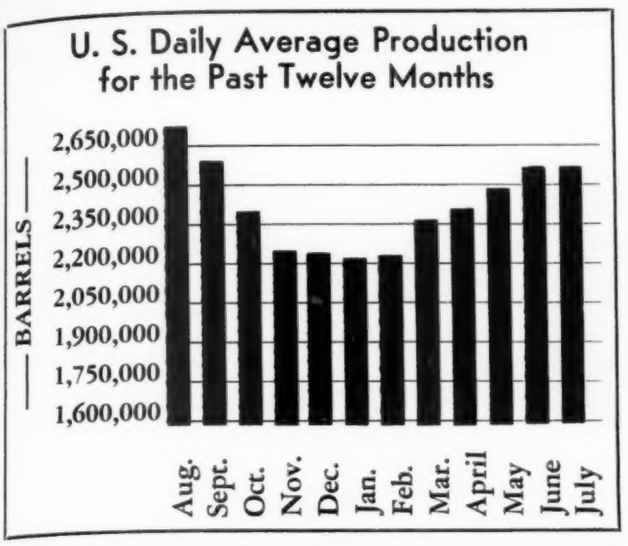
California		Louisiana	
Playa Del Rey	$ .90	North Louisiana	$ .95
Coalinga	.81	Gulf Coast	1.04
Signal Hill	1.12	Illinois	1.12
Montana	1.35	Kentucky	1.17
Wyoming	1.00	Indiana	1.12
Colorado	1.00	Ohio	
New Mexico	.75	Lima	1.30
Texas		Michigan	1.02
North Central	.95	Pennsylvania	
Panhandle	.83	Bradford	2.55
West Texas	.70-.75	Southwest	2.22
Gulf Coast	1.04	Eureka	2.17
Darst Creek	.87	Buckeye	2.07
East Texas	1.00		
Kansas	1.00	West Virginia	2.07
Oklahoma	1.00	Canada	2.10
Arkansas	.70		

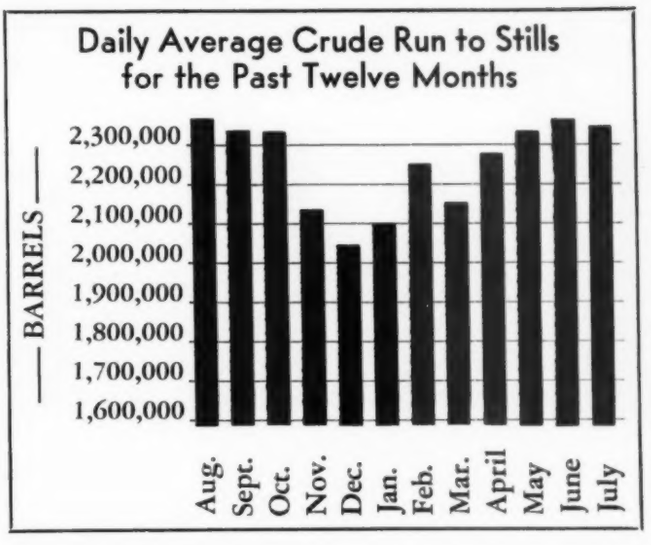
DAILY AVERAGE CRUDE OIL PRODUCTION

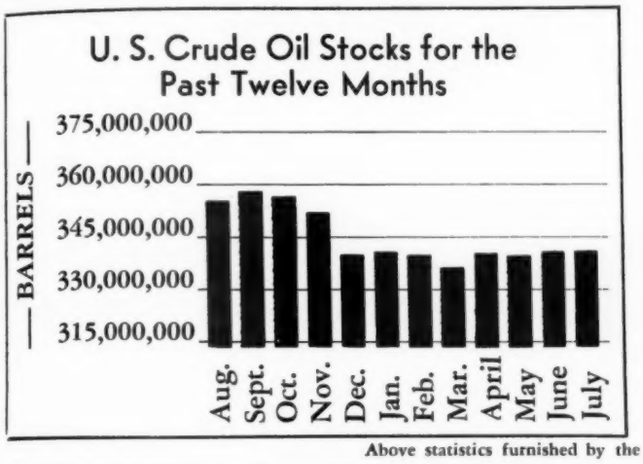
(Figures in barrels)

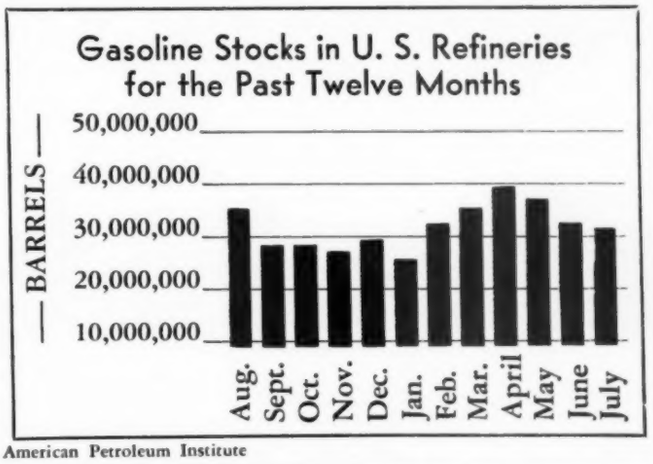
Furnished by A.P.I.

	Federal Agency Allowable Effective July 1	Week Ended July 28, 1934	Week Ended June 30, 1934	Week Ended July 29, 1933
Oklahoma	489,500	491,750	515,100	600,600
Kansas	134,500	136,750	131,350	125,500
Panhandle Texas		62,750	58,900	55,600
North Texas		58,700	57,750	50,750
West Central Texas		27,100	27,450	21,850
West Texas		147,900	145,150	158,200
East Central Texas		51,550	54,900	58,400
East Texas		468,650	507,750	583,650
Conroe		47,300	52,100	84,100
Southwest Texas		56,250	49,200	52,600
Coastal Texas (Not incl. Conroe)		123,100	118,850	125,750
TOTAL TEXAS	1,042,100	1,043,300	1,072,050	1,190,900
North Louisiana		24,550	25,250	26,050
Coastal Louisiana		73,600	67,550	46,450
TOTAL LOUISIANA	88,900	98,150	92,800	72,500
Arkansas	33,000	32,050	31,550	31,250
Eastern (Not incl. Michigan)	108,900	100,000	104,750	93,100
Michigan	33,200	30,100	31,850	19,950
Wyoming	33,200	37,250	37,000	29,700
Montana	8,000	8,900	8,750	7,250
Colorado	3,000	3,400	3,000	2,400
TOTAL RK. MT. ST.	44,200	49,550	48,750	39,350
New Mexico	46,600	47,400	48,800	37,600
California	509,400	518,300	515,000	487,100
TOTAL U. S.	2,530,300	2,547,350	2,592,000	2,697,850









Above statistics furnished by the American Petroleum Institute

Summarized Operations in Active Fields for July, 1934

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas								
East Texas	332	327	51	297	3600	2	40	Rotary
Duval County	24	19	4	10	2300	2	22	Rotary
Refugio County	13	12	1	19	5200	2	38	Rotary
Conroe	12	11	2	11	3000–7400	3 or 4	40	Rotary
Archer County	92	62	28	71	660–1800	1 or 2	40	Rot.-Cab.
Oklahoma								
Osage County	29	21	31	57	380–2850	2	37.5-40	Rot.-Cab.
Oklahoma City	13	8	7	37	6500	3	39	Rotary
Kansas								
McPherson	26	21	6	59	2900–4300	2	38	Rot.-Cab.
Ellsworth Arch	38	20	16	76	3300	4	37	Cable
Harvey County	7	7	3	14	3450	2 or 4	37	Rot.-Cab.
California								
Kettleman Hills	3	3	3	26	8300	3 or 4	40	Rotary
Long Beach	3	3	8	24	7000	3	26	Rotary

Field Activities by States for July, 1934

State	Completions July	Completions June	Producers July	Producers June	Locations July	Locations June	Rigs July	Rigs June	Drilling Wells July	Drilling Wells June	Production, 1933 (In Barrels)
Arkansas	10	9	5	5	6	15	10	16	37	38	11,682,100
California	24	35	21	35	50	63	59	49	324	308	173,126,800
Colorado	2	1	1	1	....	....	4	5	34	35	954,900
Illinois	2	6	1	1	....	....	6	6	5	5	4,250,000
Indiana	14	16	8	6	....	....	2	2	36	35	730,000
Kansas	99	77	65	52	67	114	34	53	168	193	41,927,700
Kentucky	17	4	15	3	....	....	3	4	39	37	4,610,000
Louisiana	70	58	35	38	62	92	51	75	173	212	24,487,800
Michigan	51	53	33	40	39	48	89	115	132	159	7,790,800
Mississippi	3	2	1	1	....	....	3	3	12	16	Gas Prod.
Montana	22	12	19	11	....	....	11	11	61	54	2,128,700
New Mexico	10	6	9	5	....	....	15	7	62	61	13,086,600
New York	....	....	....	....	....	....	1	1	6	5	3,150,000
Ohio	50	102	36	74	....	....	41	57	195	185	4,300,000
Oklahoma	165	180	109	111	133	222	97	126	398	440	181,133,200
Pennsylvania	35	22	30	22	....	....	36	33	114	121	12,690,000
Texas	857	883	649	695	940	1158	319	434	1140	1275	396,993,600
West Virginia	10	15	9	12	....	....	35	26	67	63	3,825,000
Wyoming	6	5	4	4	....	....	12	11	68	68	11,211,000
Total	1445	1483	1049	1115	1297	1712	823	1031	3076	3317	898,078,200

PROGRESS OF MAJOR PIPE LINE WORK

FIRST deliveries of crude from the Kirkuk field have been made to Tripoli, Syria, over the Iraq Petroleum Company's pipe line, several weeks ahead of schedule, as they were not expected until some time in September. The filling of the line started early in June, at which time half the pumping stations were completed, and it is estimated that the line is now in position to transport to the Tripoli terminal on the Mediterranean Sea at the rate of approximately 20,000 bbl. daily, an amount representing half the maximum capacity of that branch of the line. The southern branch, with its terminal at Haifa in Palestine, will not start delivering crude for several weeks.

The Tripoli terminal has fifteen 93,000-bbl. tanks completed or under construction and deep-sea loading facilities have been finished. Present plans call for the remaining pumping stations to be completed in time for the northern branch of the line to be operating to full capacity before the end of the year.

●

The Pure Oil Company is reported making plans for a pipe line to the Bosco field in the Gulf Coast area. A route from the new producing area to the Gueydan field, a distance of 32 miles, already is under way. The proposed line will connect with the Pure Oil Company's 12-mile line from Gueydan west to the Mermentau River.

●

Construction work has been started by the Shell Pipe Line Company on a 20-mile line connecting the Roanoke field of Louisiana with its Iowa, Louisiana, station. At Iowa it will tie into the 22-mile line running to Kaough's landing south of Lake Charles on the Calcasieu River.

●

The United Gas System, Houston, Texas, is installing a compressor station near Woodlawn, Louisiana, in the Iowa field. Two major buildings will house ten compressors with a total of 1700 horsepower. Capacity of the station will be 11,000,000 cu. ft. daily. Residue gas will be taken from the Shell Petroleum Corporation's natural gasoline plant (now nearing completion) and delivered to the compressors through an 8-in. line. Eight miles of line will be laid for this purpose. The compressor station will receive the gas at 40-lb. pressure and increase it to 400 lb. for delivery into the United's main pipe line from Texas that serves southwestern Louisiana communities.

●

The General Petroleum Company has constructed a new pipe line, approximately 12 miles in length, from the Mountain View field of California to the company's Rose pump station. The line is of 6-in. pipe, welded, and at the Rose station connects with the General's 10-in. trunk system that extends from the San Joaquin Valley to Los Angeles. This is the third short pipe line to be laid from the Mountain View field during the year. The others were constructed by the Union Oil Company and the Standard Oil Company.

●

Nash and Windfohr, of Graham, Texas, plan to lay ten miles of 4-in. line from their No. 1 Atwell in south Young County to the shallow Loving oil pool, to deliver gas for repressuring purposes. They also may construct a line to the town of Loving and supply that community with gas for domestic use.

●

A 25-mile 6-in. oil line is being constructed by The Texas Pipe Line Company from its wells on the western edge of Foard County, Texas, north to a point near Acme, Texas, where it will join with the company's trunk line from the Panhandle to the Gulf. A small pumping station and two 55,000-bbl. tanks will be built at Acme. The line will supplant the one now connecting with the Magnolia Pipe Line Company's line to the west.

●

Oil is being run through the Artesia Pipe Line Company's new 4-in. carrier from the Maljamar field, 42 miles east of Artesia, New Mexico, to the Malco Refining Company at Artesia. The line was laid by the Fredell Construction Company, Denver, Colorado, and Houston, Texas. The line connects with a gathering system in the Maljamar field, extending to the properties of the Grayburg Oil Company, the Repollo Oil Company, the Danciger and the Dexter-Arnold interests.

●

A. J. Hardendorf, president of the Fredell Construction Company, Denver, Colorado, and Houston, Texas, announces his company has been awarded a contract by the Stanolind Oil and Gas Company to recondition and wrap ten miles of line from Hogback to Farmington, New Mexico.

●

The route of the American-Michigan Pipe Line Company's 55-mile natural gas line from the Austin Township, Mecosta County, pool to Muskegon is being surveyed under the direction of E. L. Fischer, of Davenport, Iowa, engineer for the United Light and Power Company. Construction work will not begin, however, until Taggart Brothers, Inc., of Big Rapids, have fulfilled a contract to bring in another gas well in the Mecosta field, assuring a minimum of 4,000,000 cu. feet. The completion recently of two wildcat gassers in Hinton Township, Mecosta County, and Belvidere Township, Montcalm County, southeast of the Austin Township pool, gives rise to the belief that sufficient gas reserves are available to warrant early construction of the line.

●

The International Pipe Line Company's 6-in. oil line from the Cut Bank field of Montana to Sunburst, a distance of 30 miles, has been completed and is delivering oil. At Sunburst the line connects with that of the Illinois Pipe Line Company running to Coutts, Alberta, Canada. The crude is transported to the Maple Leaf refinery at Coutts. The International Pipe Line Company is a subsidiary of The Texas Company.

The new line was completed in approximately 20 working days at a cost of $200,000. Roger Moore and Company of Shelby, Montana, were the construction contractors.

The line ties into The Texas Company's 14-mile gathering system extending from the Santa Rita's tribal wells at the northern extremity of the field to the loading racks at the town of Cut Bank. O. M. Webb, superintendent for the International Pipe Line Company, announces that additional gathering lines will be laid in the south Cut Bank field as soon as sufficient production is developed in that area.

●

Work on reconditioning the Uinta Pipe Line Company's line from Baxter Basin in southern Wyoming and Hiawatha Dome in northwestern Colorado to Salt Lake City, Utah, is progressing rapidly. In spots the line is badly pitted from soil corrosion and electrolysis and is being insulated with a covering of asbestos and relayed. In all approximately 200 miles of trunk and gathering lines will be reconditioned.

PRESENTS A

BURST PROOF STEAM HOSE

The ideal hose for pile driver service, steam supply lines for oil barges and railway cars, boiler tube cleaning service and many other applications.

Here is absolute safety for your operators . . . "U. S. Matchless" high-pressure steam hose will not burst . . . It will outlast ordinary steam hose by a wide margin . . . Recommended for pressures up to 200 lbs. saturated steam . . . Unlike ordinary steam hose, the cotton plies of which are charred by the steam and burst without warning, the braided ply, steel wire carcass of "U. S. Matchless" is unaffected by high temperatures — it *will not burst* . . . Its spiral asbestos cord ply minimizes radiation and condensation . . . Its super quality, steam resisting tube and its heat and abrasion-resisting cover give this hose unusually long life . . . Why not write today for prices and detailed information . . . Address the "U. S." Branch nearest you, or . . .

United States Rubber Company

1790 Broadway, New York City (US) Stocks in all Industrial Centres

THE MONTH'S ACTIVITIES IN REFINING

Per Cent Refining Capacity Operated

Eastern Division, 80.3 Per Cent **Central Division, 73.8 Per Cent** **Western Division, 57.5 Per Cent**

THE Naph-Sol Refining Company, Muskegon, Michigan, has completed the installation of a 500-bbl. rerun still, and another unit of the same kind is to be erected, officials of the company state. Recently two 25,000-bbl. storage tanks were built. The plant is running approximately 2500 bbl. of crude daily, most of which is from central Michigan fields.

●

Four more independent refineries may be constructed in Michigan. Officials of the Old Dutch Refining Company of Muskegon are considering the possibility of building a 1000-bbl. plant in the Home Township field, a new pool in Montcalm County. If a sufficient supply of crude is made available the refinery will be constructed. To date there are three wells in the field with a potential of approximately 2600 bbl. daily and an allowable of 600 barrels.

Maxwell and Ray Lewis and associates of Ovid, Michigan, plan a small refinery for Elsie, south of the central Michigan producing fields. E. G. Guy, formerly of the Old Dutch Refining Company of Muskegon and the Roosevelt refinery of Mount Pleasant, will be in charge of construction work and also of operations when the plant is completed.

Max Bray may move a plant from Texas and install it at Wyman, Montcalm County.

Henry and I. E. Goodman, formerly of the Keystone Refining Company, Detroit, Michigan, have acquired a location at New Boston, Wayne County, Michigan, and are working out the details for construction of a 2000- to 3000-bbl. skimming and topping plant that is expected to be in operation by the first of the year or sooner.

●

Properties of the Altitude Petroleum Corporation have been taken over by the Bell Oil and Gas Company, under an arrangement whereby M. L. Freese and I. A. Anson of the Altitude become vice-presidents of the expanded Bell organization. With this acquisition the Bell Oil and Gas Company now has refineries at Grandfield, Oklahoma; Chanute, Kansas, and Kansas City, Missouri.

●

The Shell Petroleum Corporation's new gasoline plant in the Iowa field, Louisiana, 12 miles east of Lake Charles, is nearing completion. This will be the first plant of its kind for south Louisiana. It will have a daily capacity of 20,000,000 cu. ft. of gas and the daily output of gasoline will be approximately 20,000 gallons. The plant is on the northern part of the Shell's E. O. Stafford lease.

●

Al Clark of Taylor, Texas, and Frank Weber, San Juan Basin oil and gas operator, have purchased the equipment of the refinery one mile south of Aztec, Wyoming, and will install it at Farmington. This will be the second refinery at Farmington, the Continental Oil Company now operating a plant there.

●

The Skelly Oil Company is reconstructing its gasoline plant in the Lyman vicinity of the western Osage field, Oklahoma. Approximately four months will be required to complete the work.

●

The State Corporation Commission of Oklahoma has granted the application of R. L. Jackson and other land and royalty owners for issuance of a permit to Ben H. Ashe for construction of a carbon black plant near Guymon, Oklahoma, in the Texas County gas field. The plant will cost approximately $500,000 to erect.

●

The Cargray Corporation of Amarillo, Texas, has announced plans to increase the capacity of its well-pressure type absorption gasoline plant from 100,000,000 cu. ft. to 150,000,000 cu. ft. daily. The plant is located in northeastern Carson County.

●

James C. Graves of Saginaw, Michigan, is to construct a casinghead gasoline plant in the Porter oil field, Midland County, Michigan, this summer, he announces. At present there is no casinghead plant operating in the Porter area.

●

The 5000-gal. natural gasoline plant of the Skelly Oil Company at Fairfax, Oklahoma, is now operating. The plant has gas-fractionating equipment, and is producing 26-70 gasoline. More than 1,000,000 cu. ft. of gas is handled daily.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending July 28, 1934

A.P.I. Figures

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	508,000	87.3	15,187	10,873
Appalachian	93.3	105,000	75.0	1,577	1,122
Ind., Ill., Ky.	94.6	332,000	78.7	7,388	4,025
Okla., Kans., Mo.	83.7	256,000	66.3	5,007	3,522
Inland Texas	47.6	94,000	56.3	1,051	1,526
Texas Gulf	97.5	487,000	88.2	3,816	8,106
Louisiana Gulf	96.4	122,000	75.3	1,359	1,934
No. Louisiana-Ark.	83.7	64,000	83.1	253	502
Rocky Mountain	66.7	38,000	59.4	798	634
California	96.9	458,000	55.7	12,161	78,639
TOTALS WEEK:					
July 28, 1934	89.7	2,464,000	73.0	48,597	110,883
July 21, 1934	89.7	2,431,000	72.1	49,181	109,208

BE

An entirely new .... entirely different .... method of pumping oil wells from any depth

Kobe, Inc., now presents a method of pumping oil wells that is fundamentally different, and yet . . . can be operated and maintained by the present field personnel and will fit practically any existing field condition.

The Kobe method successfully utilizes fluid operation; eliminates the use of sucker rods and all massive surface equipment; provides hydraulic power at the pump, and automatic production control; and attains efficiencies that cannot be equalled by other production methods.

That the Kobe method will materially lower the cost of pumping oil is a fact now well established in actual field practice. Of even greater importance is the promise it holds of greatly extending the limits of economical pumping.

Bulletin No. 34-100 illustrating and describing the Kobe Pump and method of pumping will be supplied promptly on request.

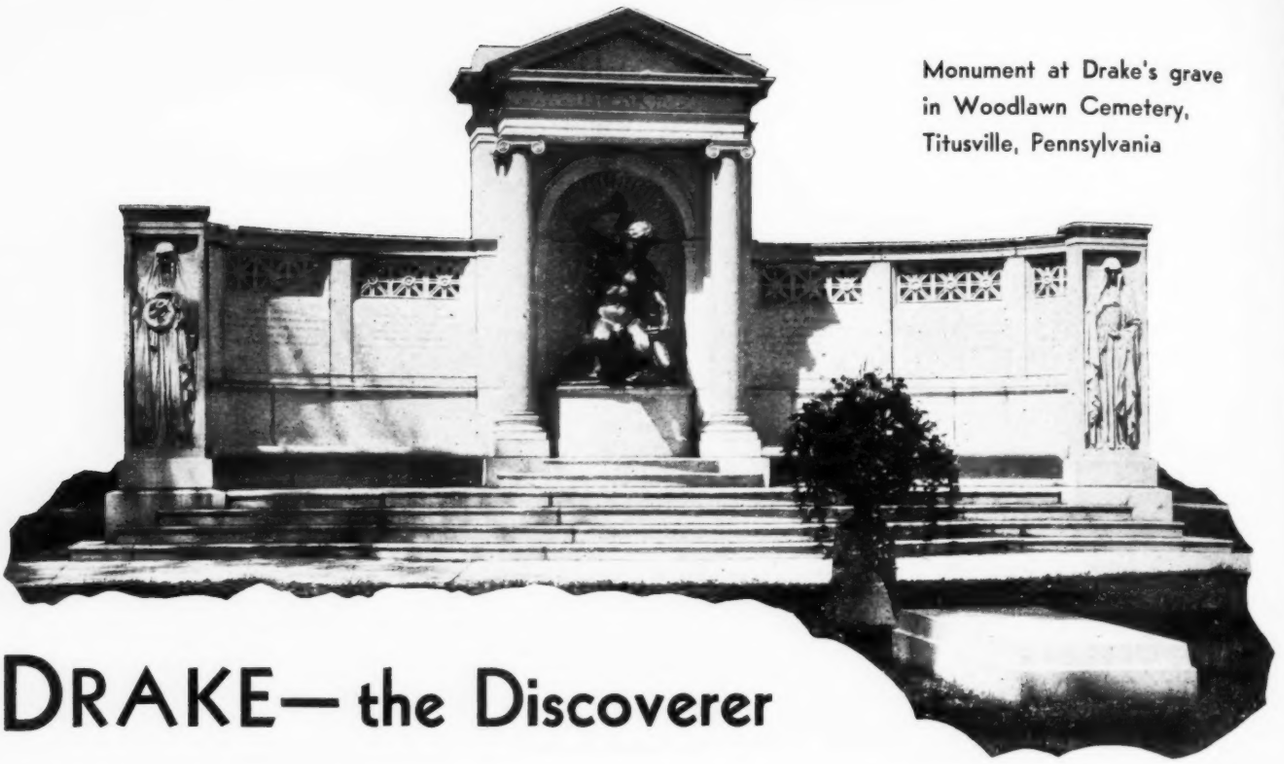
Important Features
of the
KOBE HYDRAULIC
DEEP WELL PUMP

Power At The Pump.
No Sucker Rods.
No Massive Surface Equipment.
Higher Production Efficiencies.
Greatly Reduced Power Costs.
Lower Maintenance Costs.
Utmost Safety To Operators.
Automatic Production Control.
Economical Pumping To Greater Depths.
Operates Efficiently In Crooked Wells.
100% Salvage Value.

KOBE, INCORPORATED
(Pronounced KŌB)

Manufacturers of
KOBE Heat-Treated
Screen Casing . . .
and KOBE Pumper

3040 EAST SLAUSON AVE., HUNTINGTON PARK, CALIFORNIA



Monument at Drake's grave in Woodlawn Cemetery, Titusville, Pennsylvania

DRAKE—the Discoverer

IT is natural, perhaps, that the seventy-fifth anniversary of the drilling of the first oil well would again bring into prominence the name of Edwin L. Drake. Natural, too, that new information should be brought to light in regard to him. Natural, likewise, that old legends should be revived.

A strange man, Edwin L. Drake! Perhaps, in the final analysis, not a great man. There are those who argue that Drake was simply a tool and an instrument in the hands of others. There are others who go to the other extreme and say that Drake was a genius, that he was inspired, driven by a dream. Those who have dug beneath the surface, who have talked with those who knew the man, who were familiar with all the circumstances surrounding the situation, are content to steer a middle course.

He was born on March 11, 1819, near Greenville, New York, on the farm owned by his father. At 18, his father was dead and young Drake's immediate duty was to his mother and his brothers and sisters.

For many years he worked at many things. He was, for an interval, night clerk on a boat running between Buffalo and Detroit. He even tried his hand, unsuccessfully, at farming. Finally, after being an express agent, he achieved his ambition and became a conductor on the New York & New Haven railroad.

He had married Laura Dow in 1857, and the couple were very happy. But misfortune came in the form of illness and Drake had to get a leave of absence from his job. In New Haven he met James Townsend, one of the promoters behind the Pennsylvania Rock Oil Company. At the time, Drake's savings had dwindled to $200. Townsend told him the story of the first incorporated oil company. How the company had been organized by two young and enterprising attorneys, Bissell and Eveleth—how the company owned the site of a mysterious oil spring on the banks of Oil Creek, near the village of Titusville in Pennsylvania. He fired the imagination of Drake with the idea that the flow of oil could be stimulated and that a ready market existed for the oil. The earnings of the Pennsylvania Rock Oil Company would be stupendous, Townsend promised. Drake eagerly dug up his meager savings and invested them in stock.

Then ensued a period when Drake waited for the promised dividends. He haunted the offices of the Pennsylvania Rock Oil Company. He was gauntly melancholy, gently insistent. His presence, in the office lobby, when potential stock purchasers appeared, was not good for business. Day after day he came. Then the promoters, so the story goes, decided to rid themselves of the man.

Drake was called in before Townsend, Bissell and Eveleth and asked how he would like to go to Titusville to see if he could stimulate the flow of oil from the spring. At this point the testimony is conflicting. Some say that Drake was sent to Titusville for the express purpose of drilling an artesian well at the site of the oil spring. Others claim that the idea came from the label on a bottle of medicinal oil. The important point is that Drake was to be sent to Titusville and that he was to be provided with a fund of $1000 to increase the flow of oil. Before leaving, the crafty promoters told him that they would address his mail to "Colonel" Edwin L. Drake. Drake smiled one of his rare smiles and accepted the title. He looked the part; he was tall, serious looking and his carriage was erect and he had the air of a man accustomed to giving orders and having them obeyed.

The story of the drilling of the world's first oil well has been told so often that there is scant excuse for retelling it now. We are concerned in this brief article more with the character of the man.

Drake had in his hands, dozens of times, the opportunity of making great sums of money. For example, in the process of drilling the well, a vein of quicksand was encountered

and for over a month the drill failed to gain a foot. Then Drake conceived the idea of driving a piece of heavy pipe through the quicksand. Had he invented this process he would have died extremely wealthy.

When the well was drilled and started to produce at the rate of 20 barrels of oil a day there was a rush to tie up adjacent territory. Drake smiled his slow and quiet smile but refused to join the others. "I have tapped *the* vein!" he said, quietly and firmly.

Following the drilling of the discovery well, Drake was engaged in litigation with the New Haven people who had sent him to Titusville. When he had exhausted all the funds they had supplied he wrote them an urgent letter, asking for additional funds. They showed a soggy reluctance to part with any more funds. Then Drake's sturdy stubbornness came to the surface. He was convinced, rightly, that 30 ft. more would enable him to tap the sand from which the oil had seeped. He approached two of his friends, Peter Wilson and R. D. Fletcher, both of whom were local merchants. He explained his situation and asked their help. Both gentlemen had no faith in the New Haven promoters but they did have faith in Drake's project and they had unlimited confidence in Drake's honesty. They jointly signed a note for $500 that enabled Drake to complete the well. Drake attempted to have this money repaid by the promoters.

Naturally the litigation caused him to leave the employment of the Pennsylvania Rock Oil Company. He was a bit dazed at the turn of events. He saw the village of Titusville turning into a small and hustling city. He saw the territory others had grabbed turn into rich and productive oil leases. Down Oil Creek valley, as far as he could see, was a forest of derricks. Others were making fortunes. Yet he was static.

Friends secured his appointment as justice of the peace. In addition, he was engaged to purchase oil on a commission for Shefflin Brothers of New York. For the first time in his troubled life he had a comfortable income. Yet he had no financial ability. He bought a home he couldn't afford and was forced to sell it at a sacrifice.

In 1863, he left Titusville with a small but snug fortune. In New York City he entered into partnership with a Wall Street broker. Speculation appealed to him. He was a dreamer, something of a gambler, and his health was steadily failing. So he plunged into speculation as a possible means of increasing his capital. In a remarkably short time he had lost all his money and his health.

COLONEL EDWIN L. DRAKE

Saddened and embittered, he moved to Vermont. His family suffered humiliation and privation. Yet Drake never made a single appeal to his more fortunate friends engaged in the oil business. He was still a proud man, still stubborn.

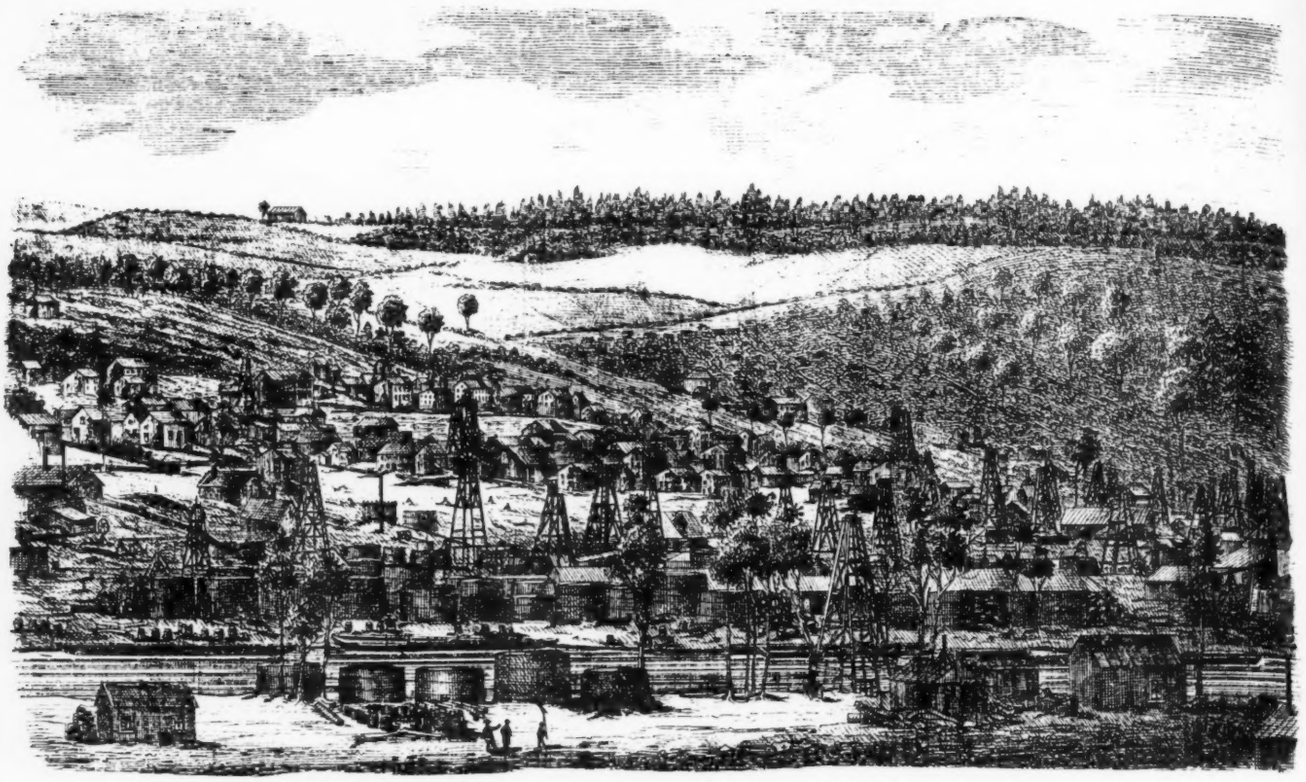
In 1869 "Zeb" Martin of Titusville ran across Drake in New York City. He was bent and frail and his mouth was twisted with pain and his eyes were sunken and tragic. He had just 80 cents in his pocket. He had come to New York in an effort to find a job for his 12-year-old son. That effort had been fruitless. Martin greeted Drake warmly, insisted on giving him some funds and came back to Titusville, where he promptly called a meeting of oil men and explained to them the condition of Drake and his family. It was the sort of story that appeals to the best in men—the discoverer of untold wealth in abject poverty. So they subscribed $4200 for Drake that night. The story was given publicity and four years later the Commonwealth of Pennsylvania voted an annual pension of $1500 to Drake and his wife during the life of either.

Drake's last days were as near comfortable as possible. There were no financial worries. Yet a man with a neuralgic spine can scarcely be said to ever be comfortable. His last years were spent in a wheel chair. On a cold, dark day in November, 1881—the ninth to be exact—Edwin L. Drake was released from the racking horror of constant pain. He had never whimpered during his years of suffering and he died with that slow smile etched on his face.

Was Drake a great man? Was he inspired? Or simply the paid instrument of others who planned great things? Does it really matter? He was honest. That we know. He had the capacity for making and holding friends. He was blessed with stubbornness. He was endowed with loyalty. He was worshipped by his family. Regardless of what may be said, it can never be said that he was not heavily instrumental in launching the oil industry. He was brave—that we know.

There you have the man. Perhaps he was not great as we often measure the greatness of individuals. Yet no man could have all these qualities without some of the aspects of greatness. If he lacked vision, surely that is not a cardinal sin. If he was not a financial genius, that certainly should not bar him from the Hall of Fame.

He was, I suspect, very nearly a great man. His fame will remain bright and glowing so long as wells are drilled. He was, at least, a pioneer. He helped to give a great and vital industry. Maybe that doesn't constitute greatness. But I think the man had qualities that entitle him to be considered great.



Oilfield view, 1865, on part of Tarr Farm, Oil Creek, Pennsylvania

Oilfield Development Methods

By K. C. SCLATER

EVER since the Drake well was drilled in 1859, oilfield development methods and equipment have been undergoing improvement. Local conditions in new fields and increases in drilling depth have been potent factors influencing changes.

From the days of the Drake well and for 25 years thereafter, the dominant drilling method was the standard cable-tool system.

To get a better conception of the vast changes progress has wrought since 1859, consider the bringing in of the Drake well. This important event will bear a brief recounting here.

When Drake, early in 1859, engaged Wm. Smith and his two sons to bore for oil on Oil Creek just south of Titusville, he had no precedent to guide him in his operations. Smith had had experience boring wells for salt water. When he began to drill for Drake he applied this experience, using the same system and type of tools then in use at Tarentum, Pennsylvania, for sinking brine wells. He used what is now known as the standard cable-tool system. The equipment was of the simplest type: a light string of drilling tools, weighing but a few hundred pounds, operated from the end of a walking-beam. Steam power was used. The power plant, a small reciprocating steam engine mounted on top of a boiler, was of a primitive type compared with those in use today.

Serious difficulty—serious, at least, in those days—was faced in beginning the well. The soft alluvial soil of the creek flats caved badly. No progress could be made. So serious was the trouble that the project was on the verge of being abandoned. Drake's pertinacity asserted itself when he was confronted with this difficulty. Several sections of cast-iron pipe of about 5-in. I.D. and walls about ¾-in. thick were driven successfully through the cavey surface soil to firm rock at a depth of 36 feet. This was the first time cast-iron pipe had been thus employed, and to Drake is given the credit for the idea—drive pipe has been widely used since then. The drive pipe overcame the caving trouble and drilling began about the middle of August. Progress was made at the rate of about three feet a day. On Saturday, August 27, 1859, just as the drilling crew was about to quit for the week, the drill dropped a few inches into a crevice. The well was then about 69½ ft. deep. On Sunday, the driller, "Uncle Billy" Smith, went to have a look at the well. He peered down the hole, and to his surprise found it filled with oil to within several feet of the surface. There was no further drilling. The hole was subsequently tubed and completed as a pumping well with an initial daily production of 25 barrels.

These are the bare facts of the bringing-in of the Drake discovery well. Even during the drilling of the first well for oil, Drake, forced by the problem confronting him, contributed a valuable improvement to drilling procedure. There you have a good illustration of how many of the improvements in oilfield methods have been made.

Derricks and equipment in the days of Drake were toys compared with those used on a modern deep well. A wooden derrick 15 to 20 ft. high, a string of cable-tools weighing but a few hundred pounds, a small steam engine mounted on a boiler, comprised practically the entire drilling rig. After a few years, as drilling had become deeper, we find the height of derricks increased to 60 or 70 ft., and the weight of the drilling tools to several thousand pounds. Improve-

ments and refinements were gradually added over the course of 20 or 25 years until the standard cable-tool rig was not unlike many of those in use today. In the Pennsylvania region the formations are hard and holes can be drilled to their total depth without pipe. Most of the early holes drilled had no casing, except for a piece of drive pipe or wooden conductor at the surface. Upper water was shut off with a "seed-bag" run on the tubing. Later, when well casing came into use, formation shut-offs and wall packers were employed to prevent upper water entering the well.

As drilling spread to other regions, subsurface conditions were not quite so favorable as those in the Pennsylvania region. Both in California and the Gulf Coast, unconsolidated formations gave trouble from caving. In California, it became necessary to case the hole as drilling progressed, so the calf-wheel was added to the standard cable-tool rig to handle the casing.

Soft formations in the Gulf Coast led to the introduction of the rotary in the oilfields. It first came into general use in the Spindle Top field in 1901. It was a small light machine and not to be compared with modern heavy rotaries. Its introduction began a new era in oilfield development practice. When first introduced it was primarily for drilling soft formations and was used with a fish-tail bit. About 1912 the rock bit, for use with the rotary, came on the market. This type of bit, now highly developed and perfected, has removed the early drilling limitations of the rotary and has contributed in large measure to the development of the rotary system to its present high standard.

The rotary is now the most widely used system of drilling and includes many refinements, among the more important of which are: straight-hole drilling (perfected since the prevalence of crooked holes were brought to light during development of Seminole field); mud-control in deep drilling; coring practice, including wire-line coring; drilling-in deep wells under pressure control (method first used in Big Lake field, Texas, in 1932); controlled inclined-hole drilling (developed recently by Eastman in California); electrical coring system (developed in Europe several years ago, has been in general use in American fields for about two years); and improved cementing methods (multiple-stage and series cementing processes, of recent introduction). Many other items might be discussed, such as the Halliburton and Hild differential rotary drives, modern types of rotary prime movers and power transmission, and blow-out equipment, all which have been developed within the last 10 to 15 years; but to do is without the scope of this brief article.

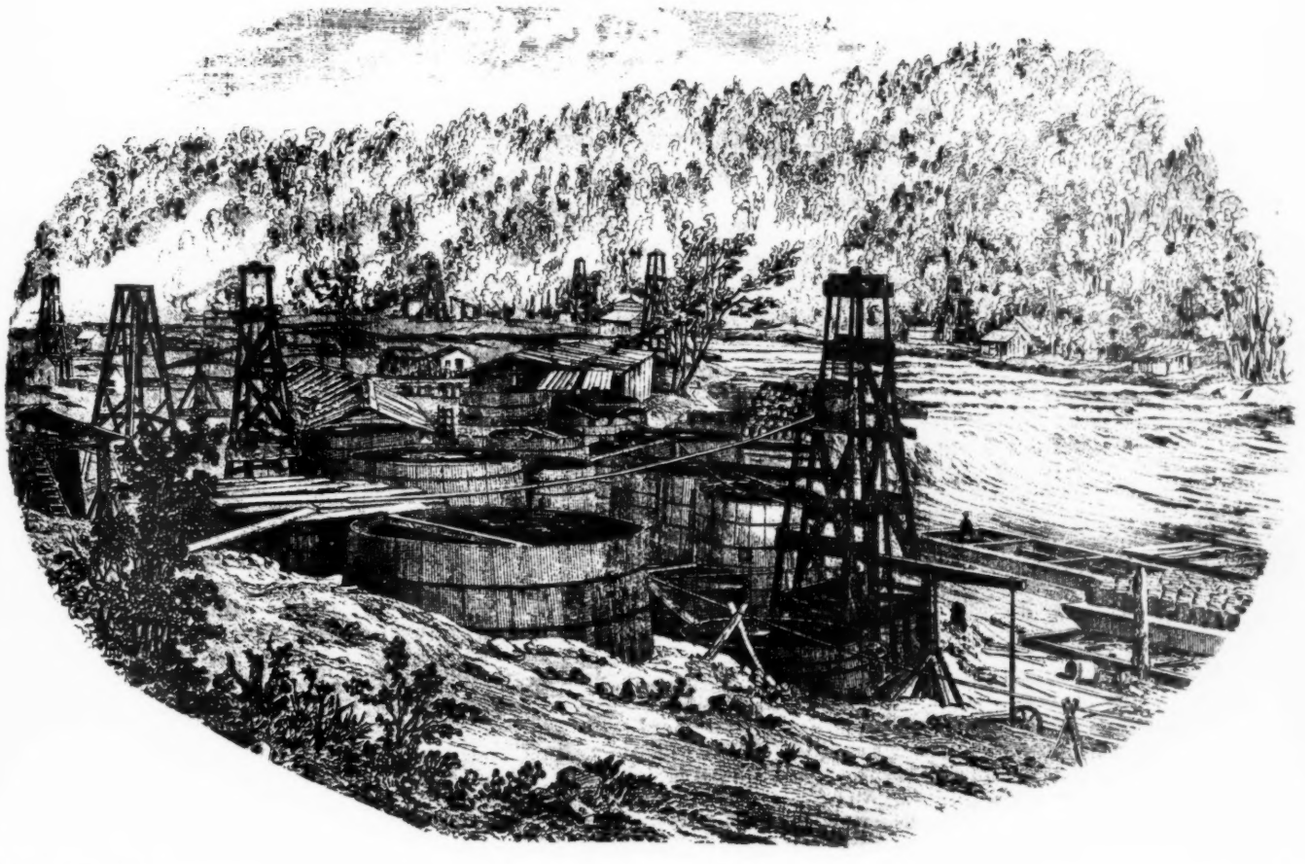
One of the most important and most recent improvements in cable-tool drilling is the coring tool for use with standard cable tools. It has been employed in the Eastern fields since 1926, in the Bradford field in particular, for coring in repressuring and flooding operations.

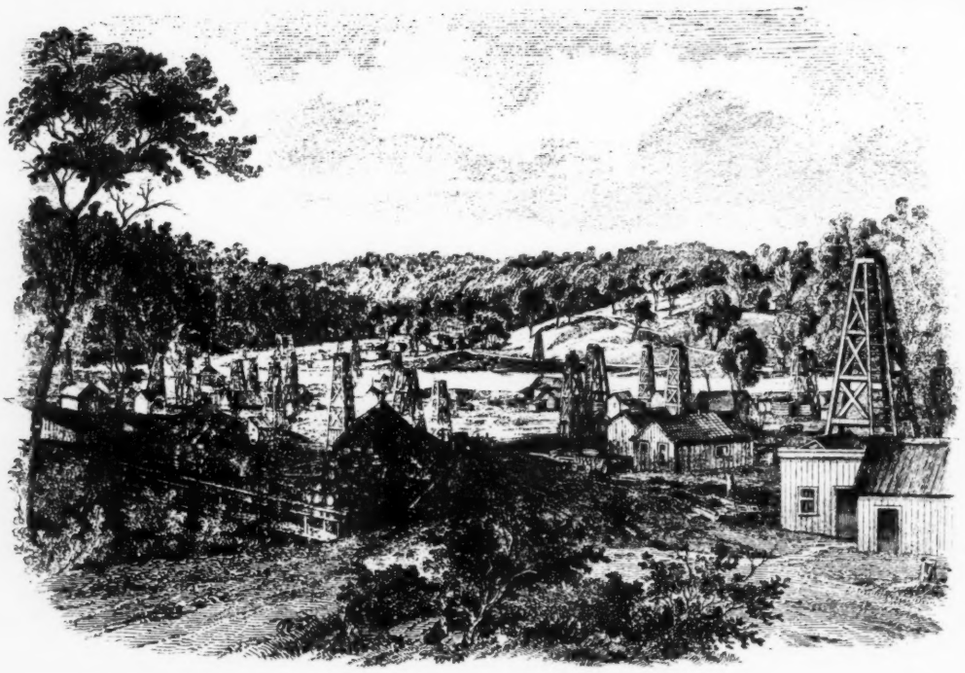
Improvements in production practice have been many since 1859. When the Oil Creek fields were developed a barrel was used to trap the gas at the well head if it was needed for fuel or other purposes. Large steel separators, designed for the proper operating pressure and equipped with baffles and control and safety valves, are used in modern production practice.

Wooden sucker rods for pumping were used in the early days, but now are obsolete. Steel or iron rods came into use in the Pennsylvania fields about 1897. They have been steadily

and Equipment Since 1859

Typical oilfield scene, Oil Creek, Pennsylvania, 1865





Oil development on Blood Farm, Oil Creek, Pennsylvania, 1865

improved to meet the growing service demands and are today in universal use for pumping wells both deep and shallow. Their manufacture today involves precision-controlled heat-treating processes, to give each rod high strength and uniformity throughout. The machining of the joints is done to close tolerances.

Air-gas drive, now known as repressuring, was first successfully used about 1903 in the Eastern fields but it did not come into general use until about 1911. Water-flooding as a method of increasing the production of oil has been in successful use in the Bradford field for many years. These two developments have large future possibilities and are the important contributions to production practice made previous to 1919, about the time interest in petroleum engineering became manifest.

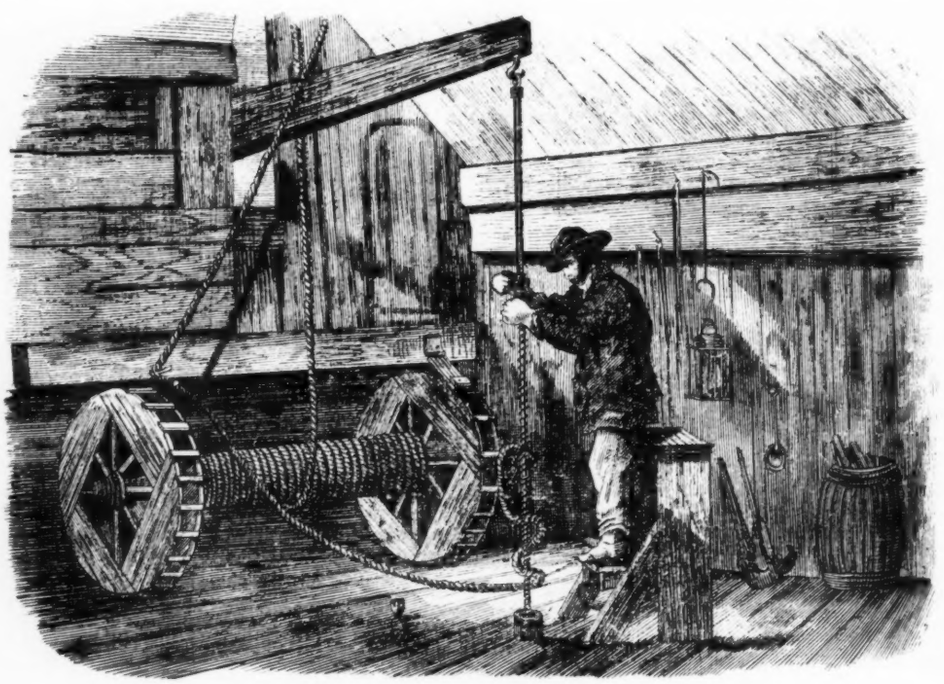
Most of the improvements in the early days were made by practical men. The engineering aspects of the problems encountered were not given much thought. Later, as drilling depths increased, problems became more complex, and about 1912, engineers of the Bureau of Mines began to give some thought to the engineering aspects of oilfield development. They were already doing some work on the physical and chemical properties of petroleum and natural gas.

In 1915, the Oil and Gas Division of the California State Mining Bureau was formed to regulate petroleum drilling activities in the State. This regulatory body has been foremost in advancing sound methods of oilfield development and well completion, including water-shut-off and the proper landing and cementing of casing. Its personnel comprises graduate engineers who are qualified by training and experience for their duties, to which they are appointed under civil service rules.

In 1919 the American Petroleum Institute was organized. Standardization of equipment was, and still is, one of the major activities. From 1919 to 1925, petroleum engineering grew in recognition among the oil companies. This was greatly aided by the Standardization work of the A.P.I., in which oil company engineers and manufacturers worked together to solve their mutual problems. They succeeded admirably. This cooperation was instrumental in putting an end to many of the wasteful practices in the use and operation of equipment. Where proper records were not kept, abuse of equipment in the field was common, much of it through thoughtless neglect or downright carelessness. Failure was often attributed to poor material or poor manufacture, when in reality field practices were at fault.

The last seven years has been a period of intensive engineering investigation and improvement in all phases of petroleum development. These are recent enough without having to be repeated here.

A well 11,000 ft. deep with a pressure of 4000 lb. at the bottom of the hole, may seem a far cry from a well 69½ ft. deep with a bottom-hole pressure of 30 lb., but the comparison adequately conveys an idea of the progress made since 1859. (The oilfield views accompanying this article are reproduced through the courtesy of W. E. Wrather, Dallas.)



On the derrick floor of a typical drilling well, Oil Creek, Pennsylvania, 1864

An early pipe line station in the Oil Creek District

Glimpses of Petroleum Pioneering Days

By HARRY BOTSFORD

THE bleak February sun slid down behind the hills and a cold wind swept across the muddy road. Almost to the top of the hill, the stage stopped to "wind" the six horses. They needed the rest; for ten miles the mud had been deep and sticky. Behind and ahead stretched a stream of horse-drawn traffic. The bronzed young man on top of the coach pulled his cape closer to him and watched with a keen and appraising eye the horsemen as they cantered past. He was enjoying this show greatly. Three weeks ago he had been discharged from the forces of Sheridan. He had returned home to find life on the New York farm monotonous and lacking in the excitement he had wallowed in for three years. Now, this!

Behind the stage coach an unlovely and profane voice asked what in hell was holding up the parade. The cry was taken up along the line of traffic and, under its urgent demands, the driver expertly cracked his blacksnake and the horses bent to the task.

Atop the hill. "There she is!" announced the driver. "Pithole City, by God!"

Sure enough! Lights glimmered and danced. Buildings came into view. Some were several stories in height; others were only rough board shacks. Music and song and profanity drifted out into the muddy streets that stretched into the darkness. On one corner two men were fighting. The young man with the bronzed face grinned. He was going to like Pithole City! In front of a hotel, agleam with oil lamps, he alighted. He was slight in appearance but quick in action. He grabbed his carpet bag and looked for a bar-room. The task was neither complicated nor difficult. He edged his way through the crowd and called for a glass of brandy. He tossed it down neatly as a good cavalryman should and laid a gold piece on the bar. The bartender swept it up, dropped it in the cash drawer. The young man waited patiently. Presently he engaged the bartender's attention. "My change, please," he asked politely.

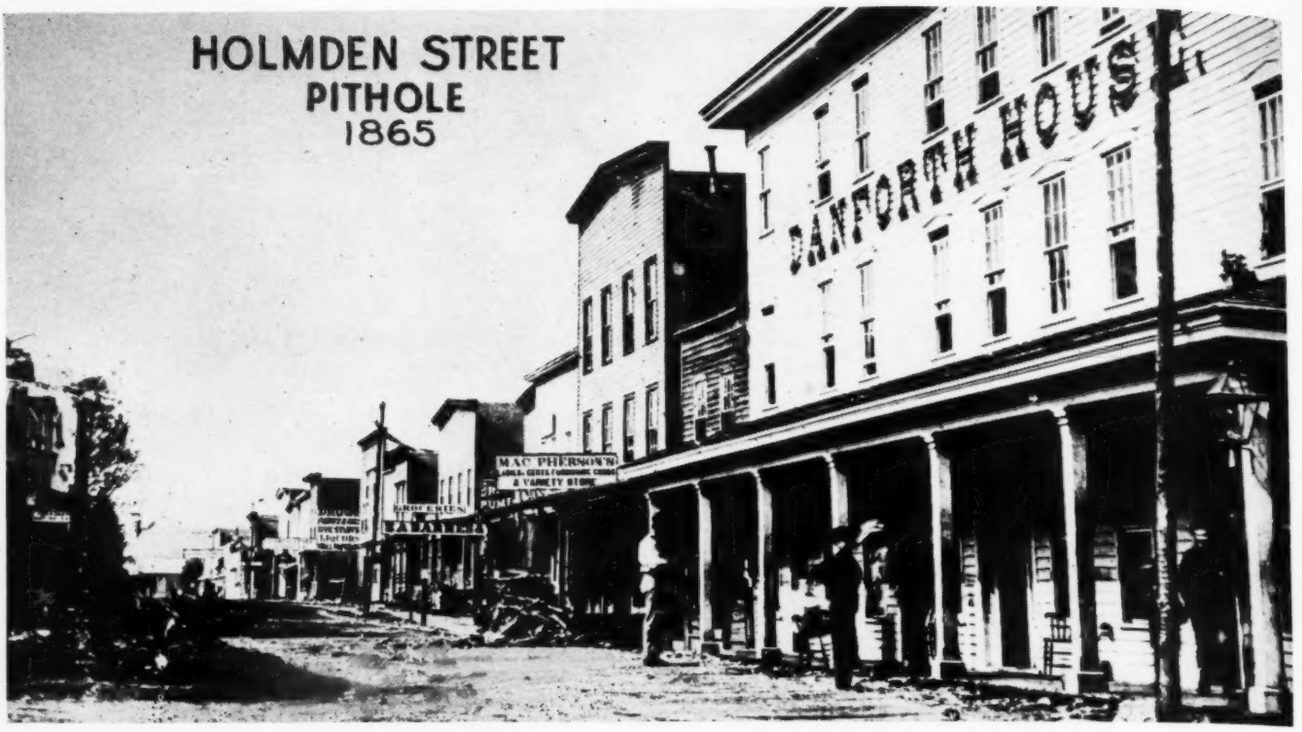
The bartender paused for a split second. "We never give change back!" he snapped. "A custom of the city."

"The hell it is!" drawled the young man as he vaulted the bar. "In that case I'll take it out of your hide!"

As I stated, the young man was slight in stature. But three years with Sheridan had taught him to fear no man. A neatly-swung bung starter caught him behind the ear and he dropped to the sawdust floor. With the ease that comes of practice, one of the bartenders picked him up, propped him in a corner out of the way. The crowd laughed and continued to drink lustily. Presently the young man regained consciousness, raised his hand to the growing lump on his head and grinned engagingly when the bartender asked him how he felt. During a temporary lull in business the bartender who had swung the bung starter so diligently explained that, while they never gave back any change, there was no rule against a customer drinking up the balance. And so it was, late that night, the young man stood outside, weaving slightly and singing a bawdy army song with three other recently-discharged soldiers.

He liked Pithole City. He saw land change hands a dozen times and grow in value each time. He heard an old farmer turn down an offer of $800,000 for a hundred-acre farm—just for a lease of the property! "Wait till I cut my buckwheat," he said. By the time the buckwheat was ripe the boom was over and the land not worth ten dollars an acre. He got to know Ben Hogan, self-styled "wickedest man in the world," and his consort, French Kate. Hogan's resorts were the acme of toughness. He watched the city grow. It was an amazing sight, fascinating to see the place grow to a point where probably 30,000 people comprised its population. Its post office, he heard, was the third largest in the state in the volume of business it did. It was a wicked and wide-open place. Yet major crime was almost unknown.

He drifted into the business of hauling oil. While two railroads were being graded into the city, oil had to be hauled



away in barrels and it was a profitable business and hundreds and hundreds of teams were so engaged. A 16-ft. plank road was being built between Pithole and Titusville. Then a story was circulated about some crazy individuals laying a pipe line between Pithole City and Miller Farm. The teamsters grinned when they heard the story. Then one day the pipe line started to work. True, it leaked. But suddenly the teamsters, or at least a lot of them, found there was no work for them. Then war was declared! One night the entire line was almost torn to pieces. Repaired, the operators were forced to police every foot of the line. Breakage, maliciously brought about, brought line losses to a point where the operators couldn't continue. The teamsters returned to work. . . .

Then Pithole City started to go down hill. A few bad fires —then wells, not wisely handled, stopped producing. Pithole came down faster than she went up. The Danforth House, a leading hotel, sold for $16 for kindling wood. It had been profitably operated for several years on land that leased for $16,000 a year. The Bonta House was raffled off, tickets selling for $10 each. Other strikes of oil were made and the population migrated cheerfully and promptly. There were no mourners, only a few hundred derricks poking up beyond the woods and a few deserted streets.

Shamburg, Red Hot, Cashup, Petroleum Center, Tarr Farm and other flaming and raging spots attracted the attention of the world. Remained only the old Methodist church. Today it is the only remaining building of the thousands that dotted the hills and valleys. It's a bleak old shell of a building, but what stories it could tell, if it could only talk.

The bronzed young man saw the whole affair. The thing burned deep into his soul and being. He never forgot. How do I know? Because that young man was my grandfather, peace to his soul and rest to his ashes.

SPRING of 1864. A dark, handsome and rather swaggering individual engaged room at the home of a Mrs. Webber in Franklin, Pennsylvania. Within a week he had presented letters of introduction, engaged in partnership with one M. J. Colman in the business of producing oil. From the start the venture was profitable.

The young man was well liked. True, there were times when he was a bit moody but when he extended himself he was easily a brilliant social success. His closest friends were Republicans and earnest and ardent supporters of the government. His carriage was graceful, and frequently he would recite in a manner that marked him as a professional. He was courteous in the extreme, yet under provocation he had a violent temper. Once when a bully kicked a dog, he gave the fellow an unmerciful trouncing, smiled and walked away.

In April of 1865 he left Franklin, telling a friend he would be gone only a few days. He carried a small bag and left behind him his books and private papers.

The next time his Franklin friends heard of him was when his name, J. Wilkes Booth, was splashed on the front pages of every newspaper in the world as the murderer of Lincoln.

Those who knew Booth when he was an oil producer have always stoutly maintained that some sudden impulse, some crazy notion, caused him to commit the crime of the century.

Not until 1869 did the heirs of J. Wilkes Booth dispose of his oil property—and that property was profitable from the start until the time of its sale.

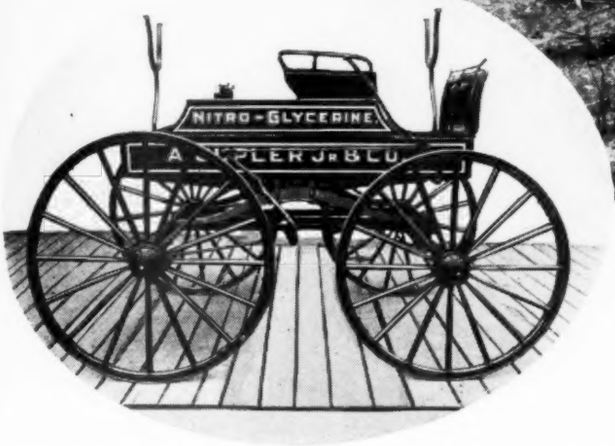
"DO you realize that if this man Roberts' experiment is a success he will have a death grip on the oil industry?" The tall, bearded man was in deadly earnest. His companion, short, fat, and red-faced, laughed. "Don't worry!" he counseled. "This idea of setting off an explosive at the bottom of an oil well has been tried dozens of times. It just don't work, that's all."

"Maybe you are right, Jim," responded the other moodily. "But I've heard this man talk and I think he knows what he is talking about. His torpedo is patented. He is going to do something the other fellows never did! He's going to use tamping—a lot of water on top of the explosive. Claims it will work, too. Says the tamping will direct the force of the explosive downward and sideward. Using that new explosive, nitroglycerine, and they say its powerful stuff."

The crowd around the "Ladies' Well" selected for the experiment, scattered, leaving Colonel E. A. L. Roberts alone on the derrick floor. He was calmly lighting the fuse of a go-devil and when smoke curled up he dropped it down the casing head and trotted briskly to a point of safety. There was a minor report, small and unimportant so the crowd thought. Then a roar came up the casinghead and the "Ladies' Well" belched a tremendous flow of water and oil. Within a few days the owners announced that production,

Right. Benninghoff Run in 1865 where some of the largest flowing wells of those days were brought in.

Below: An oil-well shooter's wagon of the type commonly used in the early days in Pennsylvania.



which had reached the vanishing point, had reached the volume the well had originally produced.

Roberts was acclaimed, rightly, the savior of the oil industry. Paraffin had met its master! Roberts calmly made known that his process was available to every oil producer—at a price; and when that price was announced the industry protested loudly, profanely, and profusely.

Efforts were made to break the Roberts patent. It was air-tight, however. Infringements of the patent were frequent. The "moonlighters" came into the picture, a hardy group of men who mixed their own nitro in wood tubs and on moonlight nights traversed rocky and half-hidden trails to where wells were to be shot at a price below that charged by the Roberts Torpedo Company. Roberts retaliated by hiring a corps of detectives and spies, and soon the courts of the Commonwealth of Pennsylvania were clogged with over 3,000 separate actions brought against infringers and those who had hired and benefited by the infringers. Before or since, no single cause has resulted in such a volume of litigation. Roberts won hands down on every case. The "moonlighter's war" covered several years, but at last the oil industry bowed to inevitable defeat and paid the toll Roberts believed to be just and ample. While it lasted it made the famed Donnybrook Fair look like a Sunday school picnic!

A WEARY teamster halted his team in front of the John Benninghoff home and looked at the yard in the hot July sun. It was a green yard, very green—but not the green of grass. Indeed, the green was in patches. He waved to Mrs. Benninghoff, sitting in a rocking chair on the porch. She was a portly woman, red of face, serene in manner. She returned the wave. "See you've got your washin' all spread out, Missus Benninghoff," he shouted. She smiled at his sally and answered in her careful English. "It draws damp in the safe, it does. Mouldy it gits if it ain't dried frequent. That's the trouble with paper money!"

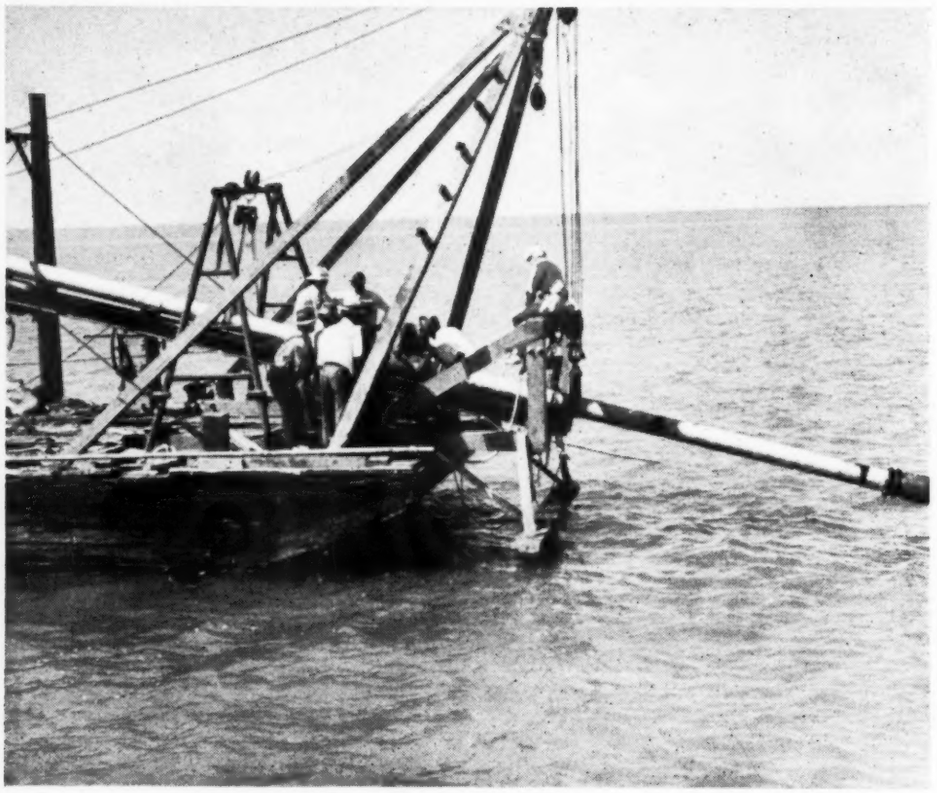
He shook his head solemnly as he drove on. "Hosses," he predicted, "some day some one will enter that house with malice aforethought and walk away with all of that wealth. Yessir! It would be dead easy. Gawd knows it would be easier than driving you over these here roads and jerkin' barrels of oil on and off. . . ."

John Benninghoff didn't believe in banks. He owned several farms, each of them rich in oil and his royalties gave him a heavy income which he tucked away in a safe.

One winter night the Benninghoffs had callers. Five of them. Possibly the teamster was among them. Who knows? They were polite but insistent. The safe was opened; $265,000 was the extent of the loot. They overlooked one packet of bills containing over $200,000. They were calm and rather casual. They ate heartily of some pies Mrs. Benninghoff had baked, and drank several quarts of milk. She protested. Not against the theft of the money, for all the money meant to her was worry and trouble. But they dropped crumbs on her floor and spilled milk on the Brussels carpet in the parlor. For weeks she complained of this untidiness and pronounced that such sloppiness was downright wicked.

The robbers were never caught. They established a record, for a time, for an all-American high in resident robberies. Benninghoff grumbled—and amassed another fortune which he prudently kept in a bank.

GREAT days, these, when the oil industry was hitting its stride. Romance there was in those early days as stark as any that ever came out of a book of fiction. Action! Drama! Comedy! Tragedy! Unbelievable the things that happened. Formative days these; days when an industry was growing and suffering from growing pains. Some day, please God, there will be a writer who will set down some of these things, properly and honestly and wisely appraised. He need not exaggerate. He need only to tell the truth and tell it in an understanding manner. When this happens a best seller will be born and the oil industry's history will be worth a place, a very prominent place, on the shelves where only literature deserves a place.



Making up new joint into coupling

New Methods Employed in R

By FRANK H. LOVE

WHEN it became necessary recently for the Galveston Gas Service Company to repair its pipe line on the bottom of Galveston Bay, officials of the company sought quicker and more efficient means of raising, repairing and relaying the pipe than previously had been employed. The accepted method of making up the joints on shore and floating them into position for coupling by a diver has certain objectionable features, chiefly the length of time required, the expense, and the fact that the necessarily great amount of handling after the joint has been made up often damages the protective coating, a condition that can not be detected or repaired under water. Company officials and engineers were confronted with the task of devising a method of taking up the line, repairing and relaying it in mid-Bay without any part of the work being done on shore. Its accomplishment required the designing of original equipment.

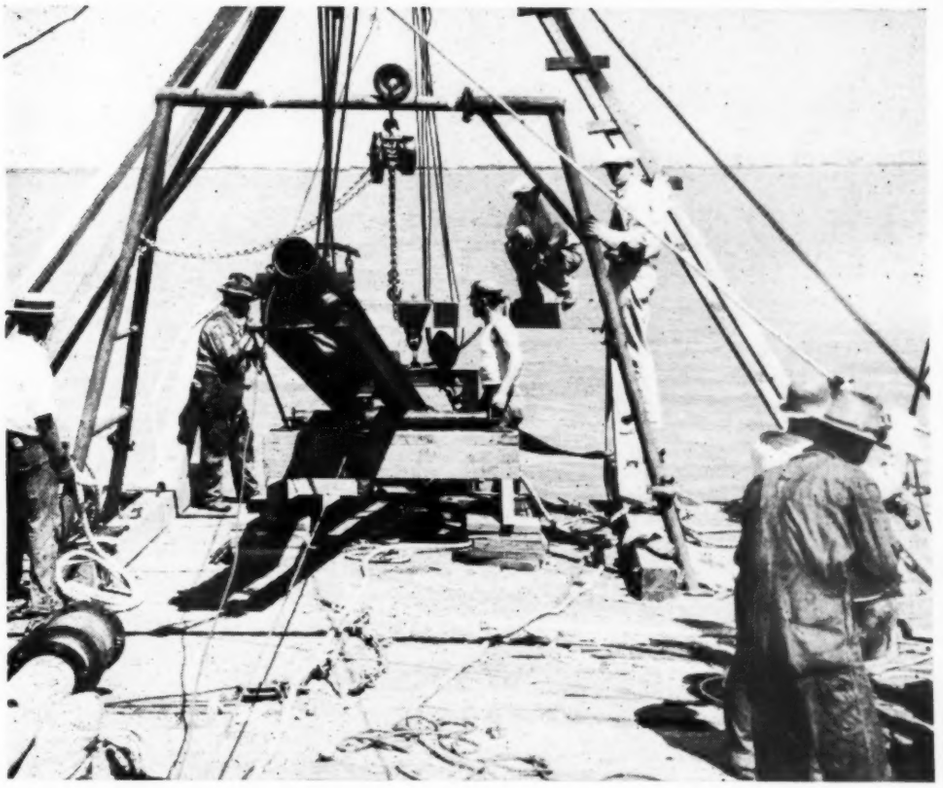
The Galveston Gas Service Company's 14-in. line runs from Lamarque, Texas (where it ties into the Houston Pipe Line Company's line), to Virginia Point, across the Bay from the island upon which is situated Galveston, Texas. At Virginia Point the 14-in. line terminates and two parallel 8-in. lines continue across the Bay to the island where the 14-in. line again is picked up, running on into the distributing plant. It was a section of one of the 8-in. lines that required repairing.

Employing a diver to examine the line, it was found that corrosion and electrolysis had affected some 350 ft. of pipe that had become uncovered, and that the portion of the pipe remaining buried was in good condition. The point at which repairs were made was approximately in the center of the Bay where the tidal current is swiftest, the water at times attaining as great a speed as six miles per hour. All repairs, the engineers had decided, were to be made from a barge, and the swift current magnified considerably the problems confronting officials.

Equipment was designed by L. B. Denning, Jr., superintendent of eastern divisions of the Texas Cities Gas Company, and Paul E. Nicholls, Galveston manager of the Texas Cities Gas Company, subsidiary of the Lone Star Gas Company, taking into consideration the swiftness of the current and the rise and fall of the barge on the water, conditions that threatened the breaking of the joints.

Upon the aft end of an 80-ft. by 22-ft. barge was constructed a framework of heavy timbers, extending five ft. over the stern. A rectangular frame-piece made of 8-in. angle iron I-beams was fitted into the timber framework. A roller of 4-in. steel shafting equipped with bearings was mounted on the lower side of the rectangular frame. Approximately 15 ft. from the aft end of the barge another roller of similar design was mounted on a movable frame. The heavy timber framework was then bolted to the deck of the barge and from this, by means of a three-way swivel, was suspended the angle-iron rectangle.

A cradle constructed of two 8-in. I-beams was joined by three steel webb-frames. Into this were fitted five oak pieces with grooved centers. When the equipment was in operation, the cradle rested on the two rollers and inclined at an angle of approximately 20 degrees. The cradle was so installed that



Running cradle overboard as pipe is lowered into Bay

Repairing Gas Line Laid in Bay

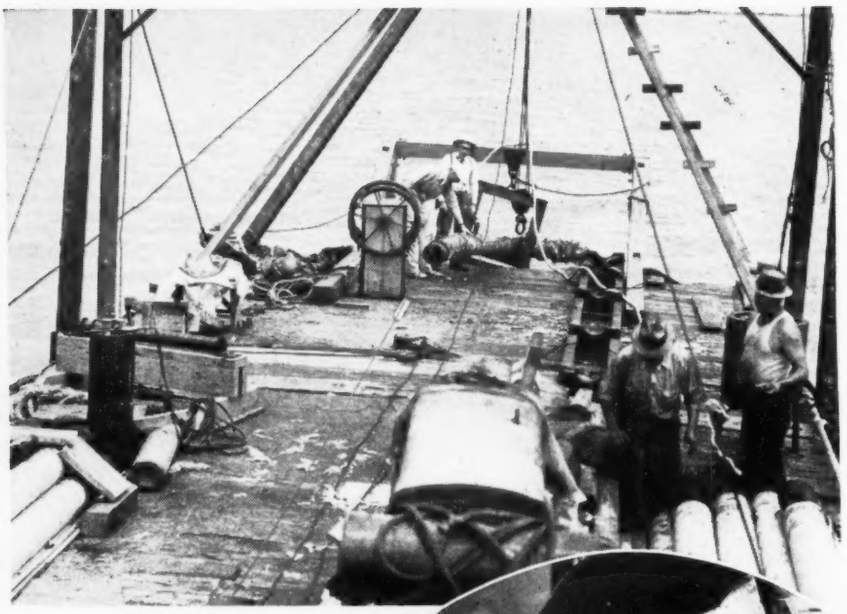
Engineers and Officials of Texas Cities Gas Company, Subsidiary of the Lone Star Gas Company, Design original equipment

it could be rolled out 15 ft. beyond the aft end of the barge. A heavy chain fastened to either side, together with the timber framework, eliminated the possibility of losing the cradle in the Bay and, at the same time, allowed enough slack to permit it to move forward and backward on the rollers, thus eliminating the possibility of the rise and fall of the barge causing a break in the pipe joints.

After the diver had located the corroded section, the pipe was raised to the surface of the Bay by means of a gasoline-powered winch, punched to make certain that no gas pocket had formed, and then torch-cut. The uncorroded end of the pipe was clamped to the lower end of the cradle and a 20-ft. length of new pipe placed in the upper end. As a screw joint was required for the type of couplings used, and equipment for threading the old pipe was not immediately available, a short section of pipe with one end threaded was welded to the line. Over the weld was placed a clamp designed for the making of rubber-packed joints, in this manner effecting not only reinforcement for the weld, but a double joint as well.

Succeeding sections of new pipe used in replacing the old was of the screw-joint type. A No. 3 type Dresser river sleeve (a combination river clamp and coupling) was employed in making the couplings. The latter was cast around a standdard steel-threaded coupling having a rubber-packed joint on each end, providing gas-tight joints and a reinforcement to the primary connection.

Upon completing a joint, the checks on the cradle were released and the barge moved forward. With a steel cable running from a connection on the second drum of the winch to a point midway of the cradle, the movement of the pipe into the water was thus under complete control of the winch operator at all times. The barge was moved from under the pipe until the end of it was within 24 inches of the vessel's stern. During this procedure the cradle moved beyond the stern of the barge approximately 20 ft. and was held in place by the clamp that secured the pipe rigidly in the cradle. To control the movement of the cradle, a split line with hooks on each end was fastened into eyes on the far end of the cradle and run up over a block in the head of the A-frame to a small hand-winch located on the stern of the barge. When the barge had moved from under the pipe a band was placed around the latter and the pipe and cradle lifted some 12 inches clear of the rollers. By taking a slight strain on the hand winch controlling the split line, the clamps were released, the cradle lowered on to the rollers and pulled forward. The pipe was then lowered into the cradle and the rear clamps made fast. A new length of pipe was placed in the cradle and the threads made tight with 8-in. lay tongs. The rubber-packed joints in the couplings were then tightened and a hot enamel coating, reinforced with a heavy gauze-type wrapper, applied to that portion of the pipe that had to be bared in order to get the coupling into place.



Top—Pipe brought up from bottom of Bay. Note the oysters and barnacles attached.

Center—Applying a hot enamel coating.

Bottom—Cradle on board—joint in position to be clamped to the cradle, which rests on angle-iron rectangle.

With the final length of pipe lowered, it was impossible to make up the last coupling above water, and a diver was assigned this work. After alignment and marking by the diver, the pipe was hoisted to the surface, torch-cut and lowered. The diver then completed the operation by aligning the two ends of the pipe, slipping the sleeve clamp in place and making up the joint.

The repairing of the line completed, it, naturally, was found to be full of water and silt. To avoid water-hammer that might cause serious damage, this foreign matter was blown from the pipe. A "wye" connection was installed on shore and gas under pressure used to blow the line free, Approximately three hours time and 400,000 cu. ft. of gas were required to clear the line.

Anticipating the possibility of high tides or rough weather, the barge was equipped with two heavy spuds, one on each side. These were constructed of 22-ft. lengths of 8-in. pipe swaged on one end to permit the welding of a 2-in. pipe coupling thereon. Into the coupling was welded a steel point. The pipe was filled with concrete to give weight, each spud weighing approximately 2,000 pounds. Casings were fastened to the barge 22 ft. from the stern, one on each side, and the spuds installed in these vertically. A frame connected the two and a line was rigged from the top of each to one of the small drums on the winch. The spuds were for emergency purposes, to use in rough weather or high tide when the regular anchors failed of their purpose. To operate, they are merely dropped, until they penetrate the bottom of the Bay.

Among the other equipment on the barge was a 6-in. centrifugal water pump, capable of maintaining a 60-lb. pressure on a 1-in. nozzle. This supplied the water pressure required by the diver, who used a water jet in uncovering the pipe and also in blasting out the ditch into which the pipe was relayed. For heating the enamel coating a regulation heavy-duty gas burner equipped with a thermostat was employed. Stargas was used for fuel. A blacksmith shop, cutting and welding apparatus completed the major equipment on board. Unusually rapid time was made on the job. The complete procedure, including rigging up the equipment on the barge and dismantling, required but eight working days. The fastest speed attained was the laying of eleven 20-ft. joints in seven hours. The average speed was somewhat less than that, due to the fact that the methods and equipment were entirely new to the men and some time was required to work out the routine and become accustomed to it. The line across Galveston Bay originally was laid in approximately five and a half months and it is interesting to note that officials of the Lone Star Gas Company believe that by employing the system worked out on this job the same line could now be installed in but a few weeks' time.

Cementing Off Intervening Water-Bearing Strata In Pay Horizons

Method developed by a major California oil company utilizes one string of casing from top to bottom with blank pipe cemented off to exclude intermediate water.

By

WALLACE A. SAWDON

Petroleum Engineer,
Los Angeles, California

WHEN the productive zone from which a well is to be produced has a thickness ranging from a few hundred ft. to one or two thousand ft., it is seldom that intermediate water-bearing strata are not encountered at one or more places. These strata must necessarily be shut off if the oil coming from above and below them is not to be badly cut and if the producing horizons themselves are to be properly protected against permanent injury. In fact, most cases necessitate the cementing off of these water-bearing strata if more than one section of the possible producing zone is to be utilized.

This condition obtains generally in the North Dome of Kettleman Hills, California, where production can be obtained from a sand thickness sometimes as great as 2000 feet. It is advantageous, however, to produce this zone through one string of casing or liner that is perforated opposite the various oil-bearing strata. Blank pipe is kept opposite nonproductive or water-bearing strata; but since the oil sands must be protected, these blank sections have to be cemented.

Several methods have been used to cement the blank sections of pipe and have been the means of developing a very efficient "series" or "multiple stage" cementing process. In some cases, the liner has been run in separate sections consisting of one part each of perforated and blank pipe. Starting at the bottom, the blank pipe of each section has been cemented before the next section of liner was inserted. One of the major companies, however, has established a method of running the entire string of casing, or combination liner, from the surface at one time, and then cementing the blank sections of pipe in stages.

This method eliminates the hazard of setting one section of pipe on the one already in the hole below where the higher section will be placed. Careful coring is, of course, done during drilling and accurate information is available for making up the pipe so that the perforated sections will be in juxtaposition to the sands from which the oil is to be taken. The string is run to bottom equipped with a cast-iron guide shoe and with cement baskets at the bottom of each blank section, just below perforations provided for the cement to pass out of the pipe.

The general details of the cementing equipment used for cementing each section of blank pipe are shown in Fig. 1. A casing bridge plug is run in and set at a position just below the perforations to provide for passing the cement to the outside of the pipe, but above the perforations through which production is to be obtained. A cementing basket, as stated, is placed in the string as the pipe is run in.

Two sacks of cement are usually dumped on the bridge plug, after which a cement retainer is run in on tubing or drill pipe. This device is set in the blank pipe at any desired position above the cement perforations. Circulation is then obtained and the cement pumped in, going through the retainer into the pipe below it, and above the bridge plug, and thence forced out of the cement perforations to its position behind the blank pipe. A back-pressure valve in the retainer prevents its return and maintains whatever pressure is on the cement.

The tubing or drill pipe is then removed from the cement retainer, which remains in place. Any cement and plugs, if used, are flushed out of the tubing or drill pipe, which is pulled up and the cementing of the blank pipe in the next section above started.

No matter how much care is used, the first cementing job is not always successful. Oil companies now use every means possible to put the hole in condition for cementing; cementing companies use the best of equipment and apply long experience toward ensuring a successful cementing job. Yet failures will occur. Of no mean advantage, therefore, is the availability of this method of series or multiple stage cementing for recementing in case of failure.

The cement retainers used are particularly adaptable for recementing, since they will withstand high pressures and contain a back-pressure valve to keep the cement in place where it is forced. When used with a bridge plug, as in the above method, the bridge plug does not have to be replaced for the recementing job after a failure if the water shut-off test is made before it is drilled up.

Example of Multiple Stage Cementing

The entire procedure of a particular series or multiple stage cementing job will show the details of the method being followed by this company. This job, illustrated in Fig.

2, was done in a well in the Kettleman Hills field. It is of particular interest because it entailed recementing and thus shows the adaptability of the cementing equipment to meet such a contingency.

The oil string, composed of 7-in. casing, was landed with a cast-iron guide shoe at 7953 feet. The casing was perforated from the bottom to 7800 ft.; from 7697 to 7503 ft.; and from 7422 to 7199 feet. Cement baskets were placed at the bottom of each of the two blank sections and a whirler cementing collar with basket was inserted at the top of the upper perforated section.

The casing above the top perforated sections was first cemented through the whirler collar. When the cement had set, the plug and cement in the pipe were cleaned out and, with a run made to bottom, the hole was conditioned by circulating for 3½ hours. After this, 12 sacks of cement were pumped in to plug the bottom of the hole.

The work of cementing behind the lower blank section of casing was immediately started by setting a casing bridge plug at 7809 ft. and dumping two sacks of cement on top of it. Outlets for the cement were, of course, perforated at the lower end of the blank pipe. A cement retainer was then set at 7732 feet. Circulation down the tubing on which the retainer was run, through the retainer and up behind the blank pipe, was broken at 1100 pounds. Using the Perkins method with two tubing plugs, 30 sacks of cement were pumped in, the final pressure reaching 1300 pounds. After this, the tubing was unscrewed from the retainer, backed up to 7720 ft. and circulation through the tubing and up inside the casing carried on for 1½ hours. The cementing plugs were found at 7735 feet.

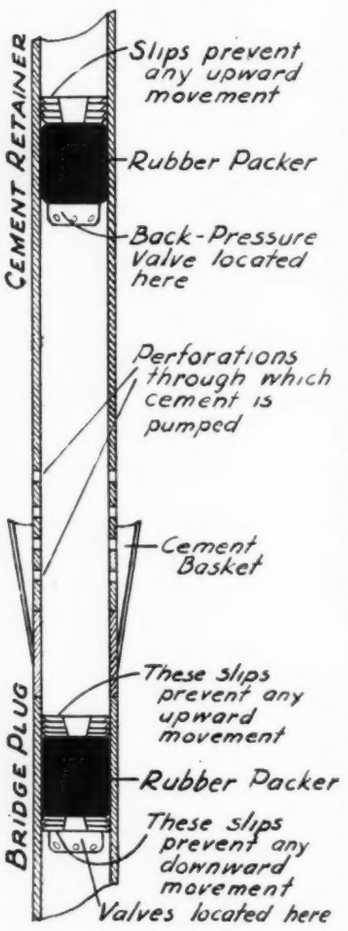


Fig. 1. Here is shown the general location of the cement retainer and the casing bridge plug when used for cementing behind a section of blank casing between perforated sections

Without delay, the cementing job on the upper blank section of pipe was commenced. A casing bridge plug for this was set at 7513 ft. and two sacks of cement dumped on it, cement outlets being perforated at the bottom of the blank pipe. A cement retainer was run on 2½-in. tubing to 7439 ft. and circulation here broken with a pressure of 1050 pounds. After cementing, the tubing was pulled up to 7416 ft., where the cementing plugs and a small amount of cement were pumped out.

Water shut-off tests are made from the top down — the reverse of the cementing procedure. The last job, from 7503 to 7422 ft., tested wet, so another bridge plug was run in and set at 7526 ft. with two sacks of cement dumped on it. The retainer was then run on 3-in. tubing to 7440 ft. and circulation obtained inside the casing at a pressure of 350 pounds. After free circulation inside the casing was established the retainer was then set, and circulation, which broke at a pressure of 1000-lb., obtained behind the casing. With good circulation behind the casing, the blank pipe was recemented at 7492 ft. at a pressure of 700 pounds. The tubing was backed off the cement retainer and pulled up to 7453 ft., where the plugs and some cement were pumped out.

Thus were two intervening barren strata securely shut-off by placing three batches of cement in three stages; one batch behind the blank pipe between 7800 and 7697 ft.; one behind the blank pipe between 7503 and 7422 ft.; and the upper batch behind the 7-in. casing above the top of the upper perforations.

After standing a week, the casing was cleaned out with a 6-in. fish-tail bit from 7438 to 7697 ft. and a packer placed at 7445 feet. The job was then tested with a pressure of 1200 lb. and the formation took no fluid.

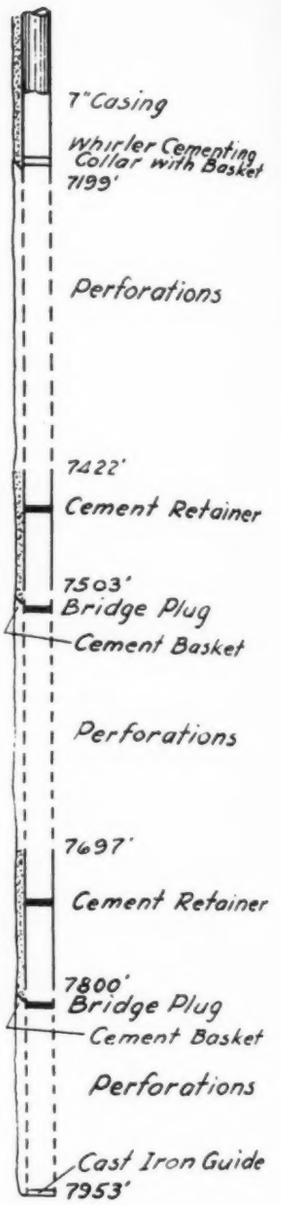


Fig. 2. A multiple stage cementing job in the Kettleman Hills field, California, where two intermediate horizons were shut off by blank pipe.

A 6-in. rock bit was used to clean out the lower job and was run to 7940 feet. Although a test with a packer set at 7723 ft. was all right at 800 lb., another casing bridge plug was set at 7814 feet. After two sacks of cement were dumped on this, a cement retainer was run on 3-in. tubing and set at 7735 feet. Circulation was now broken at 750 lb. and the lower section of blank pipe recemented at 7796 ft. with a final pressure of 900 pounds. Backing off the tubing, this was raised and the plugs, with a little cement, were pumped out.

The well was then left standing for about two weeks, when the retainer and cement in the pipe was drilled out

to a depth of 7810 feet. A packer was set at 7750 ft. and a pressure of 1300 lb. applied. The cement job tested good at this pressure. The packer was run to 7741 ft., however, and the job again tested satisfactorily with 1000-lb. pressure.

Operation of Cement Retainer

The Baker cement retainers used in the above series or multiple stage cementing operations necessarily provide for easy drilling out by being constructed with metal parts made of cast iron and the rubber packers made only ten inches in length. Their operation is diagrammatically indicated in Fig. 3.

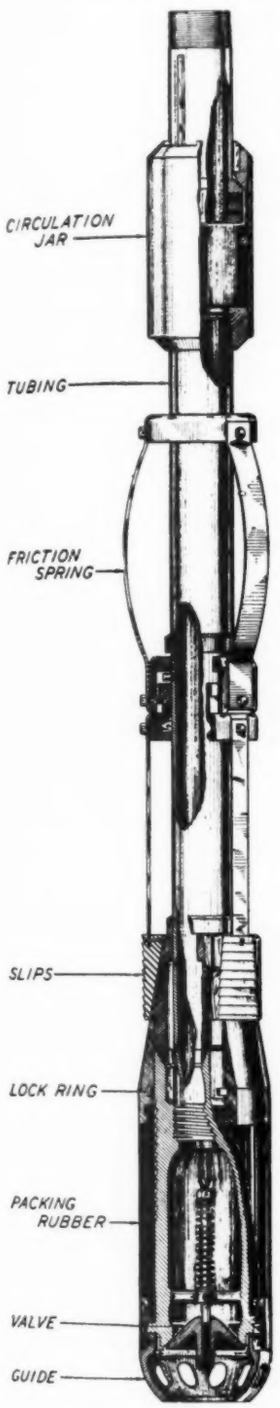


Fig. 3. The details of the cement retainer here given will indicate its operation. The back-pressure valve is shown in a closed position

The retainer is run into the hole slowly on drill pipe or tubing to prevent any down-swabbing action and to protect the packing rubber. A circulation jar, as shown, is used with the retainer and the fluid pressure will open a valve in this jar to permit fluid to enter the tubing or drill pipe without necessitating filling from the top.

When the retainer has reached the point where it is to be set, the pipe is turned to the right to release a set of slips. The tubing is then raised until the slips take hold. The place where the slips first take hold is usually marked so that the pipe will not be lowered below this point during subsequent operations. The distance required to set the slips is governed by the stretch in the tubing or drill pipe but is usually between 12 and 24 inches.

The valve in the circulation jar is operated by the strain on the pipe on which the retainer is run. When the strain is relieved—but not enough to disengage the slips—the valve is opened and permits fluid being pumped down the pipe to pass out into the casing before it enters the cement retainer. When the strain is taken on the pipe, this valve closes and makes the fluid or cement pass through the retainer.

During cementing, therefore, fluid preceding the cement can, if desired, be circulated out of the circulation jar into the casing until the cement reaches the retainer. The valve in the jar is then closed and the cement passes through the retainer to be forced outside the casing.

The back-pressure valve in the bottom of the retainer prevents the return of cement after it has once passed through. As soon as the cementing operation is completed, the tubing or drill pipe is unscrewed at the right-hand thread and is raised a few feet. Circulation is continued until the pipe is free of any cementing plugs used and of cement. Should there be a delay in unscrewing from the retainer, any excess cement can always be circulated from the tubing through the circulation jar.

Operation of Casing Bridge Plug

The casing bridge plug is similar in operation and construction to the cement retainer. As can be seen in Fig. 4, however, it has two sets of slips and two valves. These prevent movement of the plug either up or down the casing, and when the lower valve is set, allows no movement of fluid beyond the plug in either direction.

Like the cement retainer, its metal parts are made of cast iron and the rubber packing is short. It is also usually run with the circulation jar. Its trip nipple, however, contains circulation holes to meet emergencies that might require circulation. Moreover, in the lower end of the trip nipple there is a depressor bar that keeps the lower valve open while the bridge plug is being run into the casing.

The bridge plug is run in and the upper slips set in the same way as the cement retainer. When it is thus anchored against upward movement, the circulation jar is lowered sufficiently to relieve strain on the left-hand thread and the tubing or drill pipe is unscrewed from the plug. With the trip assembly and jar thus disconnected, the lower set of slips is released to engage the casing and the lower valve closes.

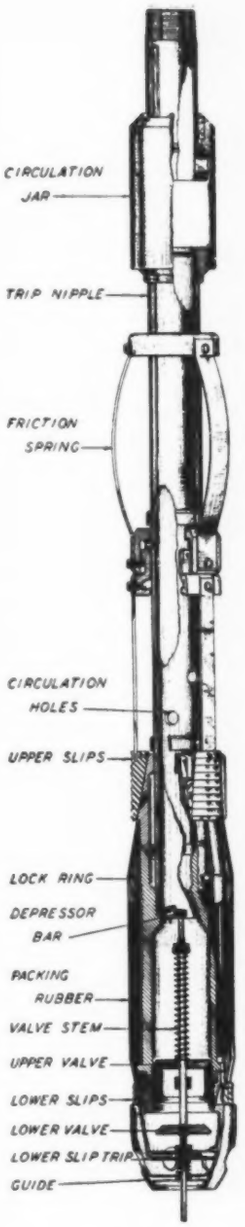


Fig. 4. The casing bridge plug has two sets of valves and two sets of slips. The upper valve is here shown in a closed position and the lower one open. The lower valve remains closed and the lower slips disengaged until the tubing is backed off and pulled up

The Significance of Light Translucency

Of Thin Adsorbed Films of Lubricants and Other Oily or Oily-Feeling Products

By S. FISCHER and EDWARD MARINOFF

Article II

EXPERIMENTAL WORK (Continued)

II. *The Establishment of the Common Point of Intersection for Viscosity (S. U.) - Percentage Light Translucency Curves of Pennsylvania Paraffin-Base Oils, Not Highly-Filtered.*

Procedure: Twenty oils were tested for the viscosity and corresponding percentage light translucency. Each curve represents a separate series of oils treated by the same process. The mode of treatment is given in Table No. 1 and the curves in Fig. 5. For data, see Table No. I.

Observations: 1. With the exception of the highly-filtered oils shown in Curve V, Fig. 4, the extrapolations of the curves pass through a common point of intersection at approximately 64 sec. at 210 deg. fahr. viscosity (S.U.) and 76.8 per cent light translucency.

2. The group of oils making up Curve I, Fig. 5, are oils having been purchased in the open market. Oils 18, 24 and 27 are indicative of vacuum processing, while oil 14, in all likelihood, is a highly-filtered Pennsylvania paraffin-base oil.

3. The oils making up Curve III are the same oils from which the highly-filtered oils of Curve V were obtained. This seems to indicate that high-filtration brings about a loss of useful values.

III. *The Durability of the Light Translucency Values of a Group of Pennsylvania Paraffin-Base Oils and that of Two Specially-Treated, Clay-Filtered Naphthene-Base Oils and the Constancy of the Common Point of Intersection for the Viscosity (S. U.)-Percentage Light Translucency Curves of Pennsylvania Paraffin-Base Oils.*

Procedure: A group of three Pennsylvania paraffin-base oils and two specially-treated, clay-filtered, naphthene-base oils were tested under identical conditions in a Ford Model A automobile engine over a distance of 500 miles. The car was driven at an average rate of 50 miles per hour and the crankcase temperature ranged from 187 to 200 deg. fahr. throughout the entire run. These oils are all sold on the open market for automobile use. The viscosities and percentages light translucency of the oils were determined before and after the run. Viscosity (S.U.)-percentage light translucency curves were plotted from data before and after the run for each group of oils. The results obtained are given in Table No. II, and represented by curves in Fig. 6.

Observations: 1. The Pennsylvania paraffin-base oils after the run show a markedly smaller loss in percentage light translucency of thin adsorbed films than do clay-filtered naphthene-base oils under the same conditions.

2. The carbon residue, after filtering the used oils, showed practically nil for the Pennsyl-

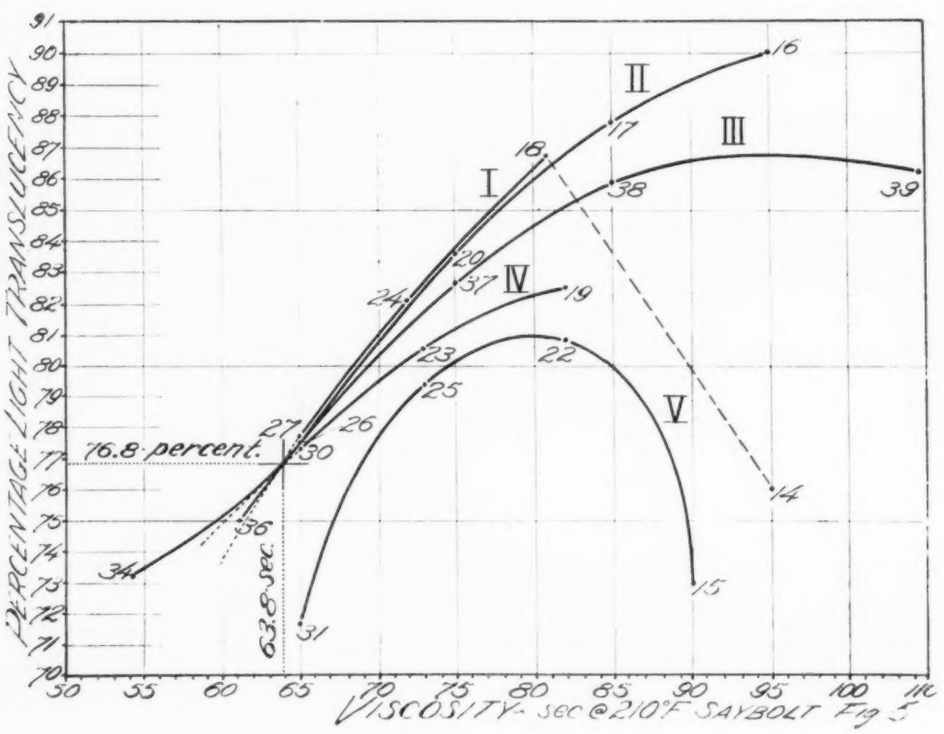
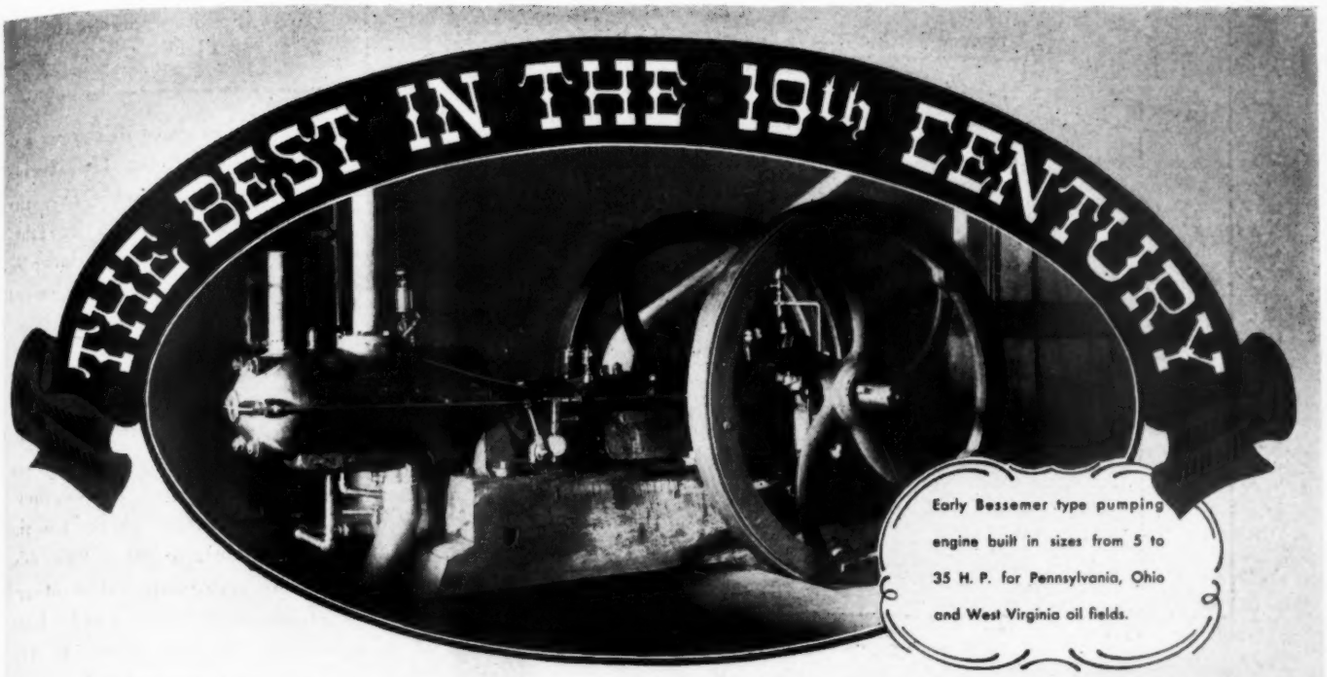


Fig. 5. Relationship between percentages light translucency and viscosities for various series of Pennsylvania paraffin-base oils showing the common point of intersection. (For curve data, see Table No. I.)

THE BEST IN THE 19th CENTURY



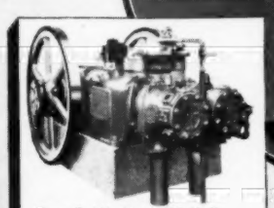
Early Bessemer type pumping engine built in sizes from 5 to 35 H. P. for Pennsylvania, Ohio and West Virginia oil fields.

ORIGINALLY a builder of steam engines, Cooper-Bessemer began designing gas engines to eliminate the steam boiler and save fuel. The line now includes low speed horizontal gas engines, both two and four-cycle types; direct gas engine driven compressors, both low and high speed vertical multi-cylinder gas and Diesel engines and large double-acting gas engines. Sizes range from 15 to 1600 H. P. for practically every oil and gas industry requirement.

A growing outlet for oil-field products is furnished by the many Cooper-Bessemer Diesels that serve industrial plants and marine craft everywhere.

1833 1934

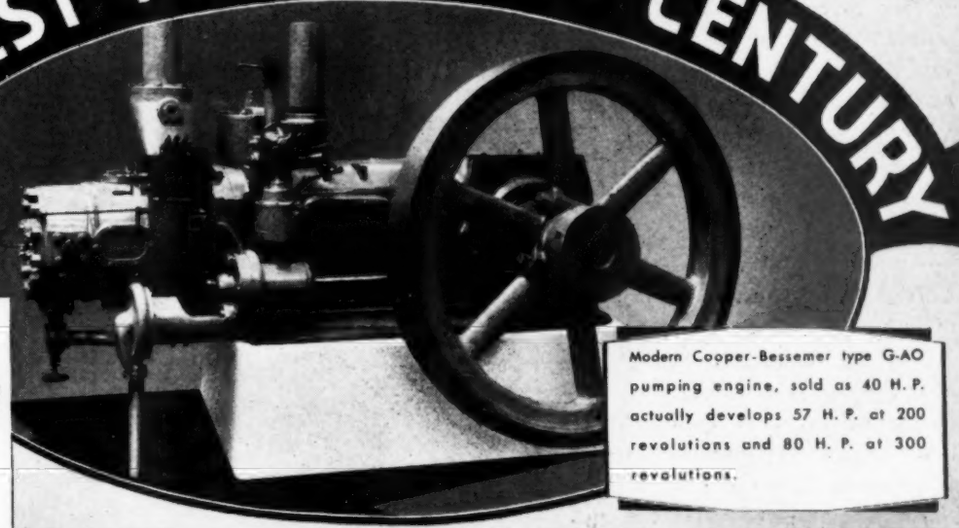
THE BEST IN THE 20th CENTURY



Type G-AU, 60 to 110 H. P.

Type G-AW, 100 to 150 H. P.

Used for driving water pumps, central pumping powers and electric generators.



Modern Cooper-Bessemer type G-AO pumping engine, sold as 40 H. P. actually develops 57 H. P. at 200 revolutions and 80 H. P. at 300 revolutions.

THE COOPER-BESSEMER CORPORATION

Mt. Vernon, Ohio — PLANTS — Grove City, Pennsylvania

840 E. 61st Street, Los Angeles, Calif. | 201 East 1st Street, Tulsa, Oklahoma | 1314 Magnolia Building, Dallas, Texas | 25 West 43rd Street, New York City | 225 Crockett Street, Shreveport, La. | 905 Esperson Building, Houston, Texas

Machinery and Engine Builders Since the Year 1833

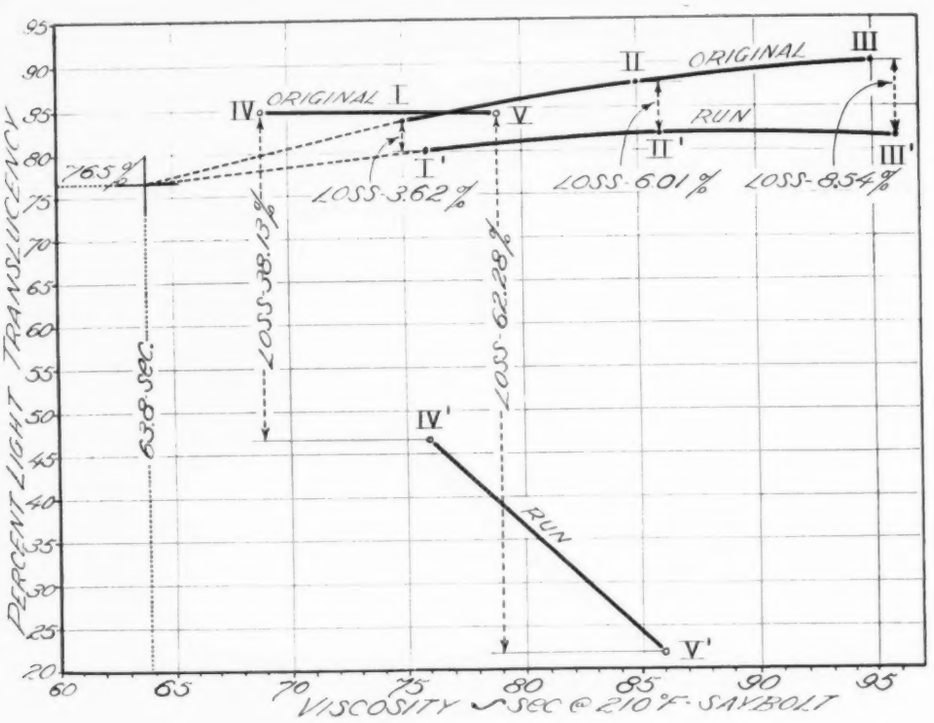


Fig. 6. Losses in percentage light translucency for paraffin-base and naphthene-base oils after run of 500 miles.

vania paraffin-base oils, while the filtered naphthene-base oils showed considerable quantities of carbon on the filter. (See Fig. 9a or Fig. 9b in next month's article.)

3. The extensions of the curves for the original and used Pennsylvania paraffin-base oils intersect at a point again at a viscosity of approximately 64 sec. at 210 deg. fahr. and percentage light translucency of approximately 76, thus checking the point obtained on unused, diversely-treated Pennsylvania paraffin-base oils, as shown in Fig. 5. This seems to indicate a marked persistency of this point.

IV. *Further Test for the Substantiation of the Coördinate Values of the Common Point Obtained by the Intersection of the Viscosity (S.U.)-Percentage Light Translucency Curves of Pennsylvania Paraffin-Base Oils.*

Procedure: Three Pennsylvania paraffin-base oils, having a viscosity in the vicinity of 64 seconds at 210 deg. fahr. (S.U.), were tested by use in a Ford Model V-8 engine, the automobile being run over a distance of 1032 miles. The three oils were subjected to identical conditions.

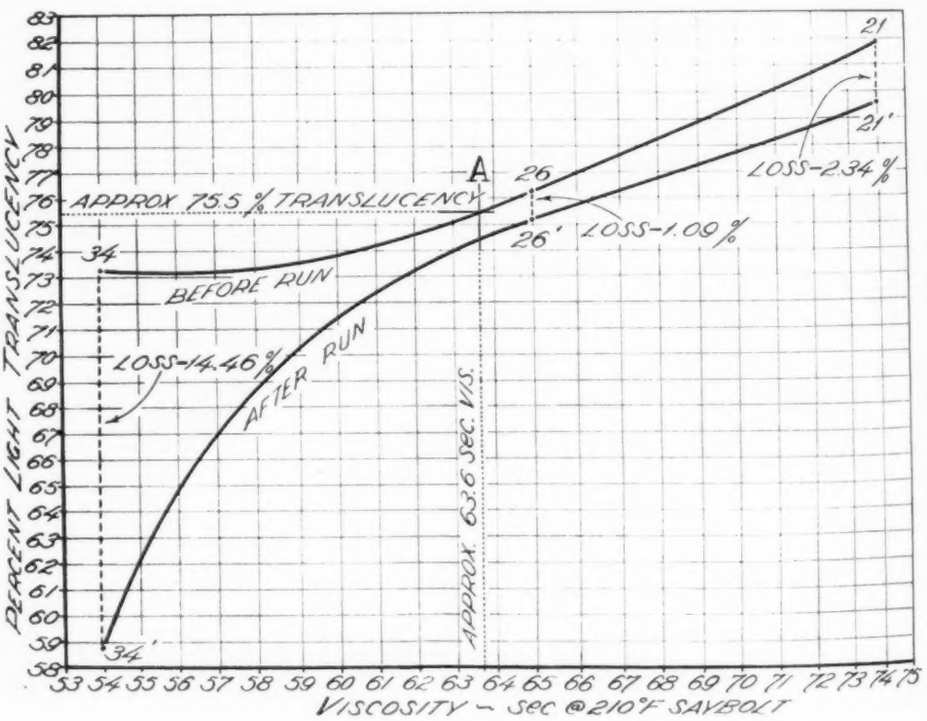


Fig. 7. Losses in percentage light translucency of a group of Pennsylvania paraffin-base oils after a run of 1032 miles.

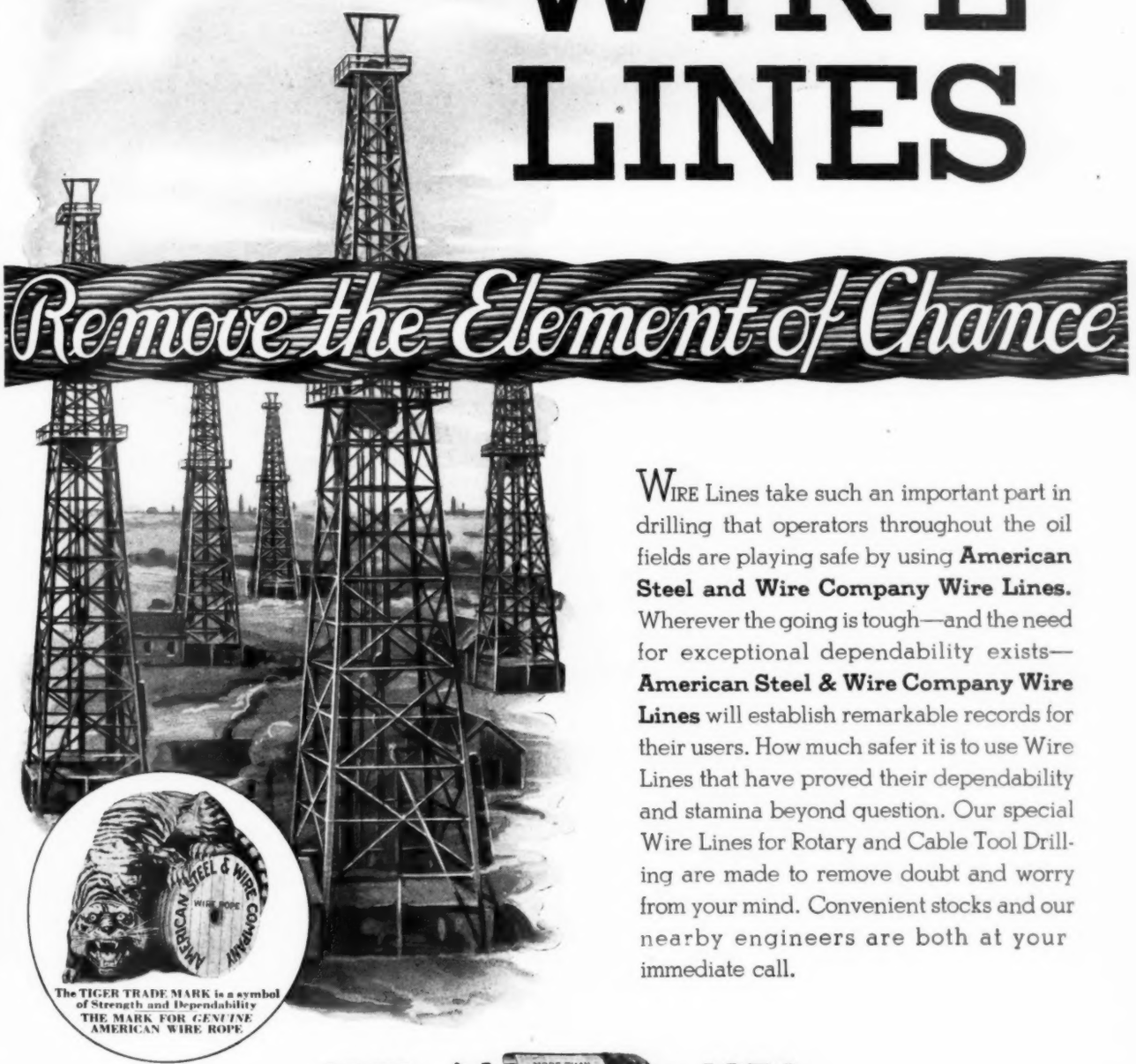
The average speed of the car was 47 miles per hour. The average crankcase temperature over the total distance was 175 deg. fahrenheit. The results are shown in Table No. III, and represented by the curves in Fig. 7.

Observations: 1. Allowing for the limit of accuracy, (1.5 per cent), it appears that the common point of intersection for the percentage light translucency-viscosity (S.U.) curves for the Pennsylvania paraffin-base oils, having coördinate values of approximately 76 per cent for light translucency and 64 sec. for viscosity (S.U.) at 210 deg. fahr., exists definitely. The maximum constriction of the two curves in Fig. 7 is at approximately 63.6 sec. viscosity at 210 deg. fahr., and 75.5 per cent in light translucency. Allowing for the accuracy of the unctuometer used in this work, this point appears to be the same point as found by the diverse methods as designated in Fig. 5 and Fig. 6.

2. It appears that the degree of loss of percentage light translucency of such Pennsylvania paraffin-base oils increases more markedly for viscosities below 64 sec. at 210 deg. fahr. (S. U.) than for viscosities above that value. This was indicated by the marked carbon deposit left on the filter upon

AMERICAN STEEL & WIRE COMPANY

WIRE LINES


Remove the Element of Chance
AMERICAN STEEL & WIRE COMPANY
WIRE ROPE
The TIGER TRADE MARK is a symbol of Strength and Dependability
THE MARK FOR GENUINE AMERICAN WIRE ROPE

WIRE Lines take such an important part in drilling that operators throughout the oil fields are playing safe by using **American Steel and Wire Company Wire Lines.** Wherever the going is tough—and the need for exceptional dependability exists—**American Steel & Wire Company Wire Lines** will establish remarkable records for their users. How much safer it is to use Wire Lines that have proved their dependability and stamina beyond question. Our special Wire Lines for Rotary and Cable Tool Drilling are made to remove doubt and worry from your mind. Convenient stocks and our nearby engineers are both at your immediate call.

1831 MORE THAN 100 YEARS of PROGRESS IN WIRE MAKING 1934

AMERICAN STEEL & WIRE COMPANY

208 South La Salle Street, Chicago
94 Grove Street, Worcester

SUBSIDIARY OF UNITED STATES STEEL CORPORATION
AND ALL PRINCIPAL CITIES

Empire State Building, New York
First National Bank Building, Baltimore

Pacific Coast Distributors: Columbia Steel Company, Russ Bldg., San Francisco

Export Distributors: United States Steel Products Company, New York

TABLE NO. III

Data for a series of Pennsylvania paraffin base oils, all run under similar conditions, as follows:
Automobile: Ford, Model "V-8."
Locale: Dry Lake, California.
Average Speed: 47 miles per hour.
Average Crankcase Temperature: 175°F.
Dilution of All Oils: 2—2.5 per cent.

Sample	Gravity °A. P. I.	S. U. Vis. at 210° F.		Percentage Light Translucency		
		Before Run	After Run	Before	After	Loss
A 34	29.7	54	54	73.27	58.81	14.46
B 26	28.9	65	65	76.22	75.13	1.09
C 21	28.4	74	74	81.94	79.60	2.34

TABLE NO. IV

Curve No.	Viscosity — Seconds at 210° F.	Gravity °A. P. I.	Percentage Light Translucency After Heating		
			25-250° C.	300° C.	350° C.
I.	Castor Oil (medicinal)		95.87	89.73	72.55
II.	Lard Oil (prime)		90.02	83.66	72.37
III.	44	20.7	88.48	81.69	68.27
IV.	60	19.2	84.82	72.92	57.85
V.	65	29.0	77.59	77.59	70.29
VI.	65	29.1	77.37	77.37	77.37
VII.	65	28.9	77.52	77.52	77.52
VIII.	65	29.1	71.64	71.64	71.64
IX.	58	22.2	57.18	57.18	50.18
X.	62	19.1	56.98	53.48	36.38
XI.	59	17.2	50.49	42.54	20.81
XII.	White (Naphthene Base)		49.78	49.78	37.01
	(Edeleanu Treat.)				
XIII.	69	17.2	49.27	35.90	20.95
XIV.	63	16.7	38.17	33.61	19.72

filtration of the used oil having a viscosity of 54 sec. at 210 deg. fahr. (S.U.), while the other two oils, having been also subjected to the same 1032-mile run, showed no such deposit at a viscosity of 65 sec. at 210 deg. fahr., and only a trace for the oil having a viscosity of 74 sec. at 210 deg. fahr. (See photographs A, B, and C in Fig. 9a and Fig. 9b in next month's article.)

IV-a. *The Effect of Heat on the Percentage Light Translucency.*

Procedure: A series of oils were heated to 250 deg. cent. (482 deg. fahr.), 300 deg. cent. (572 deg. fahr.), and 350 deg. cent. (662 deg. fahr.), respectively. The corresponding light translucency percentages were then measured. The results are tabulated in Table No. IV and represented by the curves in Fig. 8.

Observations: 1. Of the oils tested, up to a temperature of 250 deg. cent. (482 deg. fahr.), none showed a loss in percentage light translucency. See Fig. 8 and Table No. IV.

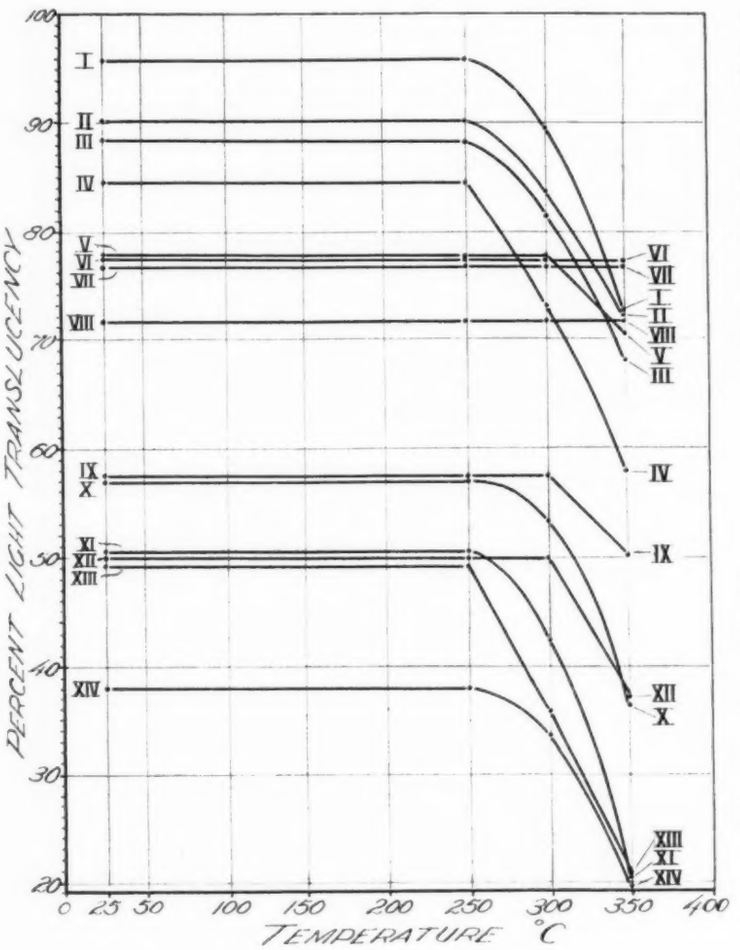


Fig. 8. Curves showing breakdown of light translucency due to decomposition.

2. Ordinarily-treated naphthene-base oils show a considerable loss in percentage light translucency. See Fig. 8, and Curves X, XI and XIV.

3. Specially-treated, clay-filtered, naphthene-base oils show a high initial percentage light translucency, but show a breakdown of the light translucency value at 250 deg. cent. (482 deg. fahr.). The percentage light translucency left, however, is, as far as has been investigated, greater than that of ordinarily-refined naphthene-base oils. See Curves III and IV for the respective types of oils.

4. Edeleanu-treated oils may or may not show an exceptionally high light translucency value, but the percentage light translucency is usually stable up to 300 deg. cent. (572 deg. fahr.). See Curves V, IX and XII.

5. Pennsylvania paraffin-base oils appear to retain their percentage light translucency up to at least 300 deg. cent. (572 deg. fahr.), and even up to 350 deg. cent. (662 deg. fahr.). See Curves VI, VII and VIII.

[This series of articles will be continued in next month's issue.—Editor.]

A Graphical Solution of Data Obtained from the A.S.T.M. Method of Charcoal Residue Testing

By

J. L. THOMPSON

Lone Star Gasoline Company

TO find the gasoline content of a given sample of gas a known amount of the gas is passed through highly activated charcoal. In the laboratory, the charcoal is heated under specifications imposed by the A.S.T.M. and the absorbed gasoline recovered. Pertinent data include the volume of the gas passed through the charcoal, the amount of gasoline recovered from the distillation, and the specific gravity of the recovered gasoline.

Since the object of the test is to find the amount of gasoline of a given gravity the gas contains, if the gasoline recovered is not of the desired gravity, the result of the test will lead to erroneous values of gasoline content, unless the result is multiplied by a factor that corrects for the difference in gravities between the recovered gasoline and the standard-base gasoline. This factor "F" is governed by the locality of the field, the type of plant (compression, absorption, charcoal, etc.), the efficiency of the plant, and the method of stabilization of the gasoline. It is indeterminate in a general way, but for any given locality its value may be determined.

The above-mentioned quantities are related by the following formula:

$$\text{G.P.M.} = \frac{A \times 1000 \times F}{G \times 3785}$$

where G.P.M. is the gal. of gasoline per 1000 cu. ft. of gas, A is the volume of the recovered gasoline in cubic centimeters, F is the factor, and G is the volume of gas in cu. ft. that has passed through the charcoal.

The value of the absorbed gasoline in cc. is plotted on the top scale of the graph. The factor lines are the lines converging towards the lower left-hand corner and are evaluated along the right-hand side of the graph. The lines representing the cu. ft. of gas passed through the charcoal are the lines converging towards the lower right-hand side of the graph, and evaluated on the left-hand side. The value G.P.M. is plotted on the bottom of the graph, ascending values to the left.

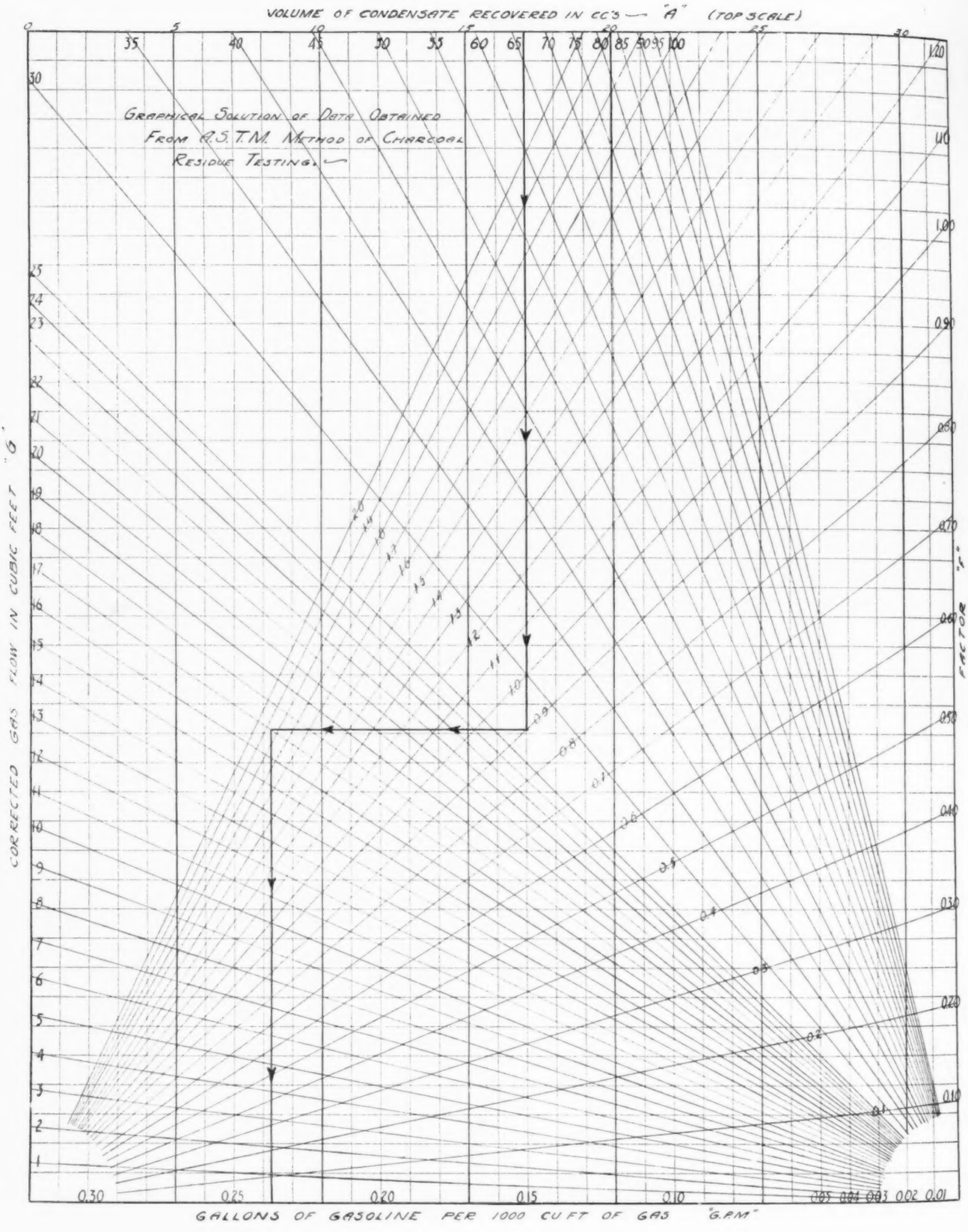
To use the graph: find the volume of the recovered gasoline in cc. along the top scale; follow this line vertically downwards to the intersection with the line representing the value of the desired factor; then proceed horizontally (either to the left or right, as the case may be) to the intersection with the line representing the amount of gas passed through the charcoal, and thence vertically downward to the intersection with the base line, where the desired answer is read.

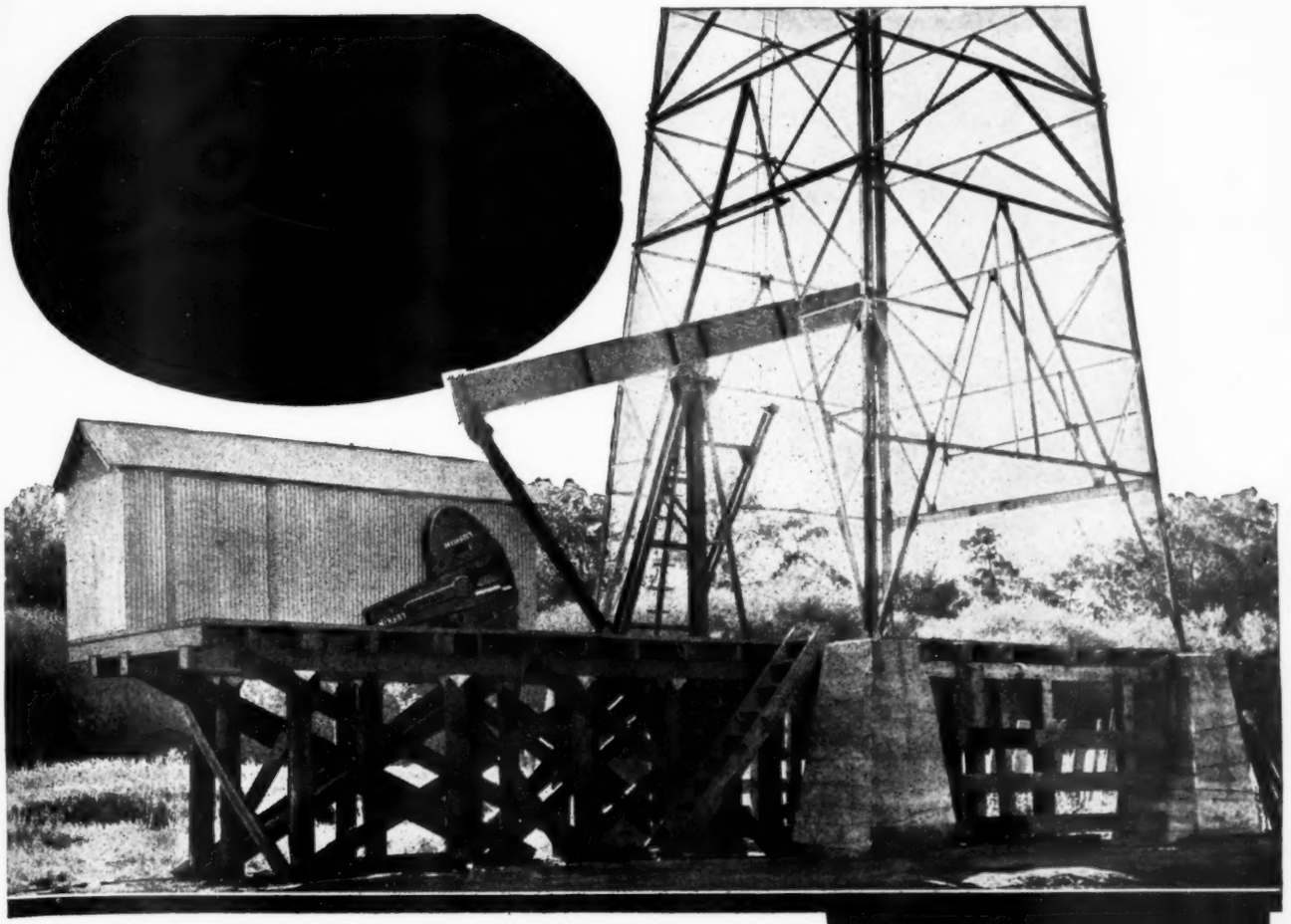
For example, suppose a recovery of 17.0 cc. of gasoline was obtained from the charcoal with a gravity such that the factor had the value of 0.90; 17.0 cu. ft. of gas having been passed through the charcoal. To obtain the gasoline content of the gas in gal. per 1000 cu. ft. of gas, the following steps are taken:

1. Find the cc. (17.0) on the top scale marked volume of condensate recovered in cc.
2. Go vertically downward to the intersection with the factor line. (0.90).
3. Then horizontally to the intersection with the line representing the cu. ft. of gas passed through the charcoal. (17.0).
4. Thence vertically downward to the base line and read the answer. (0.237 gal. of gasoline per 1000 cu. ft. of gas).

Interpolation of the chart may be facilitated by noticing that on vertical lines, equal increments of either the factor lines or the cu. ft. line cut off equal segments. For example, on the seven cc. line, each line representing one cu. ft. cuts off five squares. Thus proportionate parts may be obtained. For values of the several components of the formula not plotted on the graph, it may be seen that doubling either the volume of the recovered gasoline or the factor will double the answer in G.P.M., while doubling the amount of gas passed through the charcoal will halve the answer in G.P.M.

The accuracy of the chart has been thoroughly tested and has been found to be in the neighborhood of one-half of one per cent.


VOLUME OF CONDENSATE RECOVERED IN CC'S — "A" (TOP SCALE)
GRAPHICAL SOLUTION OF DATA OBTAINED FROM A.S.T.M. METHOD OF CHARCOAL RESIDUE TESTING.
CORRECTED GAS FLOW IN CUBIC FEET "G"
"F" FACTOR
GALLONS OF GASOLINE PER 1000 CU FT OF GAS "G.P.M."



Lufkin-equipped East Texas River Bed Installation
Deep Rock Oil Corporation

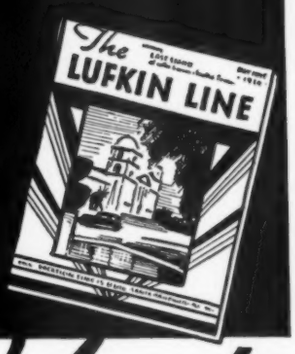
DEPENDABILITY!

Prime Requisite For River Bottom Pumping . .

River bottom pumping necessitates the very best in dependable equipment. Dependability — of increased importance during overflow periods — insures continuity of production and freedom from interrupted service — so costly to the producer.

The installation above is a typical Lufkin river bottom job — designed and equipped throughout by *Lufkin*.

A request to the Lufkin, Texas, office of the Lufkin Foundry & Machine Company will bring complete details.



LUFKIN *Pumping Units*

Engineering Fundamentals Department

- A Study Course for Field and Plant Men
- A Review for Experienced Engineers

W. L. NELSON
K. C. SCLATER
Editors

Elements of Applied Petroleum Pipe Line Transportation

Article I

THE FLOW OF OIL IN PIPES AND PIPE LINES

Part I—Review of Fluid Flow Theory and Data

By
EMORY KEMLER[1]
and
L. L. THOMAS[2]

THE determination of friction losses for viscous flow of oil in pipes has been on a sound and accurate basis for many years. The Poiseuille formula used for calculating the pressure drop for this case has been found to be practically, as well as theoretically, correct. The determination of pressure drops in the case of turbulent flow has, however, been on a rather unsatisfactory basis. Those designers who have collected data from practice and experience are able to make calculations over the range of data from their experience with satisfactory accuracy, but when it is necessary to make calculations for unusual conditions it is found that it is not safe to extrapolate their data. Those who have not had the benefit of experience must resort to the use of empirical formulas and often find them unsatisfactory.

The introduction of Reynolds number as a criterion for determining the friction coefficient or factor has done much to alleviate this difficulty. While the method proved to be much more satisfactory for solving general problems than the use of empirical formulas, the lack of data on variation of the friction factor with pipe size, type of pipe, etc., presented a barrier to the widespread use of this most useful and rational method for studying flow problems. A recent paper by the author has correlated practically all the reliable data on flow of fluids in pipes available in the scientific literature during the past 100 years. These data show how f varies with the pipe size for steel and brass pipes and give a summary of the data on flow in cement, steel-riveted, cast-iron, coated cast-iron, galvanized and used steel pipes. A recent paper by R. J. S. Pigott gives data showing friction curves for any type of pipe, based on his experience and on the author's analysis of different kinds and sizes of pipe. The data given in these two papers form a background on which designers can base their calculations and on which research workers in the field of fluid flow can plan their work to the best advantage. The character and volume of the favorable and constructive discussion on these papers indicate the growing appreciation of the value of Reynolds number in flow work, and show the extent to which the more progressive engineers are adopting it.

It is not intended to convey the idea that empirical formulas cannot be applied to some engineering problems or that they cannot give reliable results. If they are based on accurately-taken data, they will hold for the range of conditions covered in the experiments and for these conditions can be made as accurate as any other formula. If, however, it is necessary to use these formulas for conditions outside the range over which the tests were made, the formula may not hold and the results calculated therefrom will be in error. Since most of the experiments have been made using water as a fluid, it is not surprising that the use of these formulas for oil often results in large errors. The use of the Reynolds number criterion makes it possible to use the data obtained on a test using any fluid, to find the friction in the same pipe for any other fluid whatsoever, provided the physical properties of both fluids be known and that the range of Reynolds number is the same. It is this property of Reynolds number that makes it particularly useful. The use of Reynolds number essentially reduces the problem from one of four variables to one of a single variable.

The formula commonly used for determining pressure losses in pipes is:

$$dP = \frac{flv^2\rho}{2gD} \quad \text{or} \quad dh = \frac{flv^2}{2gD}$$

Where:

- dP = pressure drop in lb./ft.^{2}
- l = length of pipe in feet
- g = 32.2 ft./sec.^{2}
- D = diameter of pipe in feet
- v = mean velocity in ft./sec.
- ρ = density in lb./ft.^{3}
- f = friction factor
- dh = loss of head in ft. of liquid flowing.

[1]Engineering Division, Gulf Research and Development Corporation; Assistant Professor of Mechanical Engineering, University of Pittsburgh, Pittsburgh, Pennsylvania.

[2]Engineering Division, Gulf Research and Development Corporation.

"WE ORDER EVERYTHING FOR PIPE LINE WELDING FROM LINDE"

Everywhere . . . . .

they're Lindewelding

UP in Wyoming, an 8-in. gas line was Lindewelded in weather well below freezing. A Linde Service man helped train the welders in the latest Lindewelding technique, further reducing time per weld by 15 per cent.

In sunny California, 40 miles of 26-in. pipe was Lindewelded. Through broiling heat Linde Service Operators followed every phase of the work to high speed records with each welder making over 20 welds per day.

Winter or summer, Lindewelded pipe lines continue to lead. Lindewelding speed—doubling or tripling the daily production of sound welded joints—helps offset weather delays or obstacles which cannot be avoided. The wide experience of Linde Service men in planning pipe line welding operations helps with short-cuts to overcome right-of-way difficulties due to hilly or swampy ground, or to creek, bayou or river crossings. *Linde Process Service* is your means of having pipe lines constructed under any conditions with speed, dependability and profit.

Linde Process Service is supplied without charge to Linde customers. The features and savings it affords explain why so many pipe line companies buy *Everything for Pipe Line Welding from Linde.*

Information on the latest developments in Lindewelding is yours for the asking. The nearest Linde Sales Office has data and figures to show how Lindewelding has been profitably used on pipe lines in your own vicinity. Call, write or telephone and this helpful information will be furnished you without obligation.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

126 Producing Plants UCC 859 Warehouse Stocks

IN CANADA, DOMINION OXYGEN CO., LTD., TORONTO

LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES • UNION CARBIDE

Sales Offices:

Atlanta	Houston	Portland, Ore.
Baltimore	Indianapolis	St. Louis
Birmingham	Kansas City	Salt Lake City
Boston	Los Angeles	San Francisco
Buffalo	Memphis	Seattle
Butte	Milwaukee	Spokane
Chicago	Minneapolis	Tulsa
Cleveland	New Orleans	
Dallas	New York	
Denver	Philadelphia	
Detroit	Phoenix	
El Paso	Pittsburgh	

PRODUCT OF A UNIT OF UCC UNION CARBIDE AND CARBON CORPORATION

Users of products and processes developed by Units of Union Carbide and Carbon Corporation benefit from a most unique coordination of scientific research with manufacturing, sales and service facilities. You are cordially invited to visit this summer the numerous exhibits sponsored by the Corporation in both the Basic and Applied Science sections in the Hall of Science at Chicago's 1934 A Century of Progress Exposition.

The only difference between the method of analysis using Reynolds number and the empirical methods is the manner in which f is determined.

Reynolds, in his analysis of the problem, concluded that f would depend upon the velocity of flow, the density of the fluid, the diameter of the pipe, and the viscosity, μ, of the fluid, which group takes care of the physical properties of the fluid and their variation with temperature. If the dimensions of l, v, ρ, g, and D are substituted in the above equation for dP, it is seen that they combine to give lb./ft.^{2} which is the dimension of dP. Since the equation is to be dimensionally correct it is seen that f must have no dimensions. Since f depends upon v, ρ, D, and μ, we will have to start with a general expression in which these quantities may occur to any power but must satisfy the condition that the expression must be dimensionless. If we let β, θ, α, and λ represent the respective powers to which these may occur, then:

$$f = \phi(D^{\alpha} v^{\beta} \rho^{\theta} \mu^{\lambda}) \text{ where } \phi \text{ stands for any function of } (D^{\alpha} v^{\beta} \rho^{\theta} \mu^{\lambda})$$

Since all the dimensional quantities entering into this equation can be expressed in terms of length (L), weight (W), and time (T), we can write:

$$D = L \qquad \rho = \frac{W}{L^3} = WL^{-3}$$

$$v = \frac{L}{T} = LT^{-1} \qquad \mu = \frac{W}{LT} = WL^{-1}T^{-1}$$

$$f = \phi(L^{\alpha}, L^{\beta}T^{-\beta}, W^{\theta}L^{-3\theta}, W^{\lambda}L^{-\lambda}T^{-\lambda})$$

$$f = \phi(L^{\alpha+\beta-3\theta-\lambda} T^{-\beta-\lambda} W^{\theta+\lambda})$$

If f is to be dimensionless, then the exponents of L, T, and W must be zero.

From this condition we find that $\alpha = \theta = \beta = -\lambda$, which gives no restriction on the values of α, θ, β, and λ, but if we choose any one of them the others become automatically fixed. If we make the relation as simple as possible by taking $\alpha = 1$, we find:

$$f = \Phi\,(D\, v\, \rho\, \mu^{-1}) = \Phi\left(\frac{Dv\rho}{\mu}\right)$$

The product $\frac{Dv\rho}{\mu}$ is merely a number, as it has no dimensions, and is called Reynolds number after Osborne Reynolds, who developed the equations. Hereafter, Reynolds number, $\frac{Dv\rho}{\mu}$, will be written as R for the sake of simplicity. Fre-

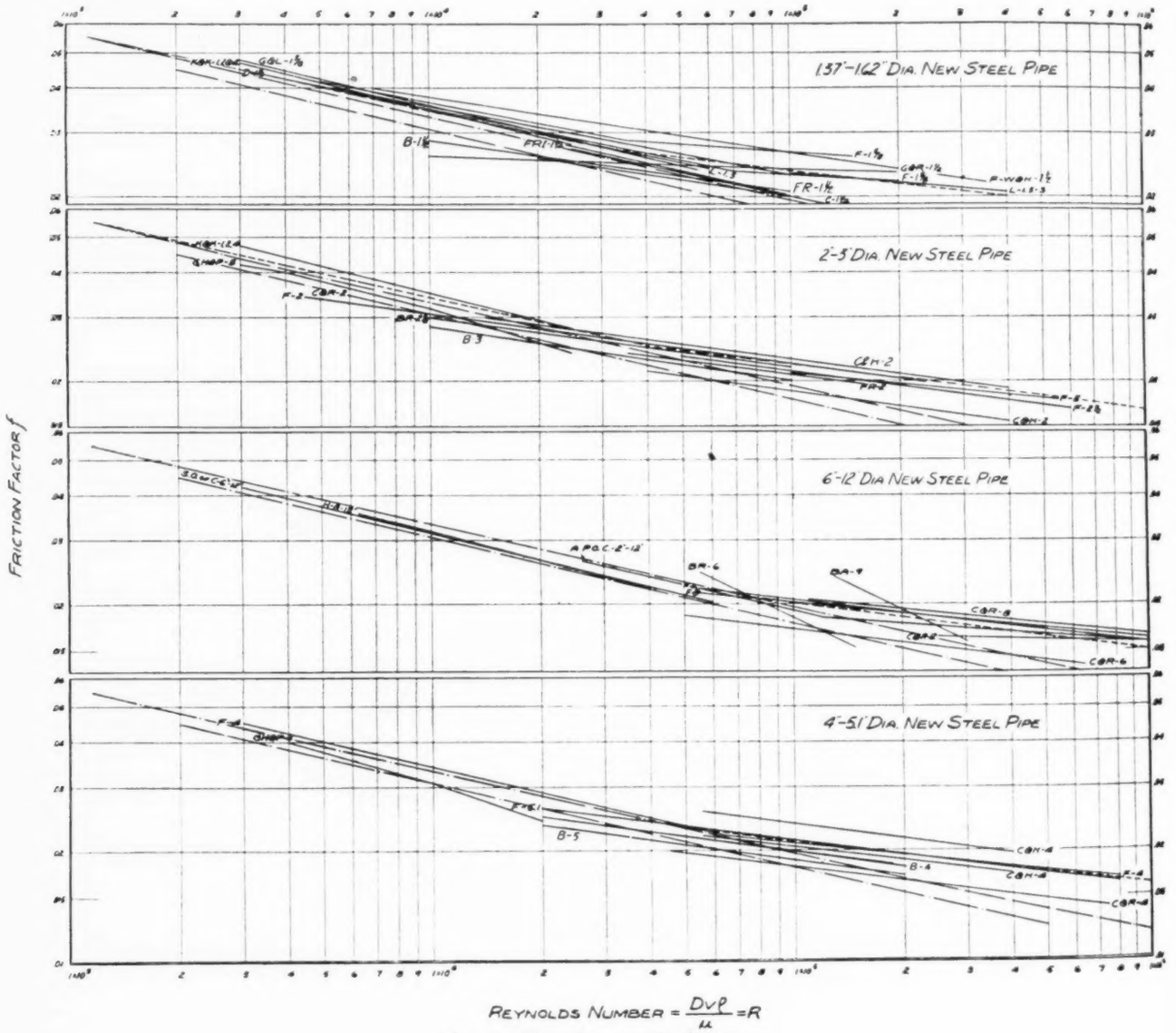

1.37"-1.62" Dia. New Steel Pipe
2"-3" Dia. New Steel Pipe
6"-12" Dia New Steel Pipe
4"-5" Dia. New Steel Pipe
Friction Factor f
Reynolds Number = Dvρ/μ = R

Fig. 1. Flow in new steel pipes

TABLE I—SUMMARY OF TESTS ON NEW STEEL PIPE

(Water is fluid used unless otherwise noted)

Experimenter	*Range of sizes (diam, in.)*	*Source of Data*	*Remarks*
Freeman (F)	0.36-8	"Flow of Water in Pipes," by Mills	Pipes had screw-joint couplings
Darcy (D)	0.48-1.55	Do.	Diameters varied 18 per cent on small sizes
Smith (S)	0.627	Do., or "Hydraulics," by Smith	Joints made by butting ends of pipe
Omkeck (O)	0.78	"Handbuch der Physik," vol. 7, p. 150, or "Forschb. der V.D.I.," vols. 158 and 159, 1914	No data available
Francis (Fr)	0.801-2	"Flow of Water in Pipes," by Mills	Apparently the same as Smith's tests
Rowland (R)	1	"Flow of Water," by Schmeer	No joints
Poche (P)	1	*Power*, vol. 34 (1911), p. 34	Couplings used
Fritzsche (Fri)	1-1.54	"Handbuch der Physik," vol. 7, p. 150	No data available
Gould & Levy (G & L)	1.38	Univ. of Ill. Eng. Expt. Bul. No. 182	No couplings. Brine used
Brix (B)	3¼-6½	Phil. Trans., vol. 214	No data given on pipe. Air used
Corp & Ruble (C & R)	½-12	Univ. of Wis., Bul. No. 1. vol. IX, p. 39	Flanged joints
Brabbee (Br)	½-6	Gresecke in *Jl. A.S.H. & V.E.*, vol. 21, p. 478	Temp. varied widely, but values not given
Kite & Kennedy (K & K)	1, 2, 4	*Jl. Ind. & Eng. Chem.*, vol. 14, No. 2, p. 112	Data on individual sizes not given. Oil used
Bayles (Ba)	8.94	Scobey, "Flow of Water in Riveted Steel and Analogous Pipes"	Standard coupling-type joints
Glazebrook, Higgins & Pannell (GH & P)	3 & 4	*Jl. Inst. Pet. Tech.*, vol. 2 (1914-1915), p. 54	No couplings, 5 ft. gage length and accurate manometer used. Oil used
Lander (L)	0.422-1.3	Proc. Roy. Soc., vol. 92-A (1916), p. 337	Joints made by butting ends of pipe. Steam and water used
Greeve (Gr)	1½	Purdue Univ. Bul. No. 2, "Flow of Water Through 1½-in. Pipe"	One coupling in 40-ft. length
Corp & Hartwell (C & H)	1-4	Univ. of Wis. Bul. No. 66, p. 83	Probably no joints
Davis (Da)	2	Univ. of Wis. Bul. No. 403	Flanged joints used
Standard Oil Co., of Calif. (SO)	——	"Flow Book"	Data from oil-pipe-line tests. Oil used
Heltzel (H)	8-12	*Oil and Gas Jl.*	Data from pipe-line tests. Oil used
Feely & Riggle (F & R)	0.27	Univ. of Pittsburgh unpublished thesis	No couplings. Air and water used
Berwald & Johnson (B & J)	1-2	U. S. Bureau of Mines R. I. 3153	Air and natural gas used
Beale & Docksey (B & D)	0.3	*Jl. Inst. Pet. Tech.*, Aug., 1932	. . . . .
Anglo Persian Oil Co. (APOC)	2-12	*Jl. Inst. Pet. Tech.*, Aug., 1932	Natural gas used
Fair, Whipple & Hsiao (F, W & H)	1½	*Jl. N.E. Water Wks. Assn.*, vol. 44 (1930), pp. 499-513	. . . . .

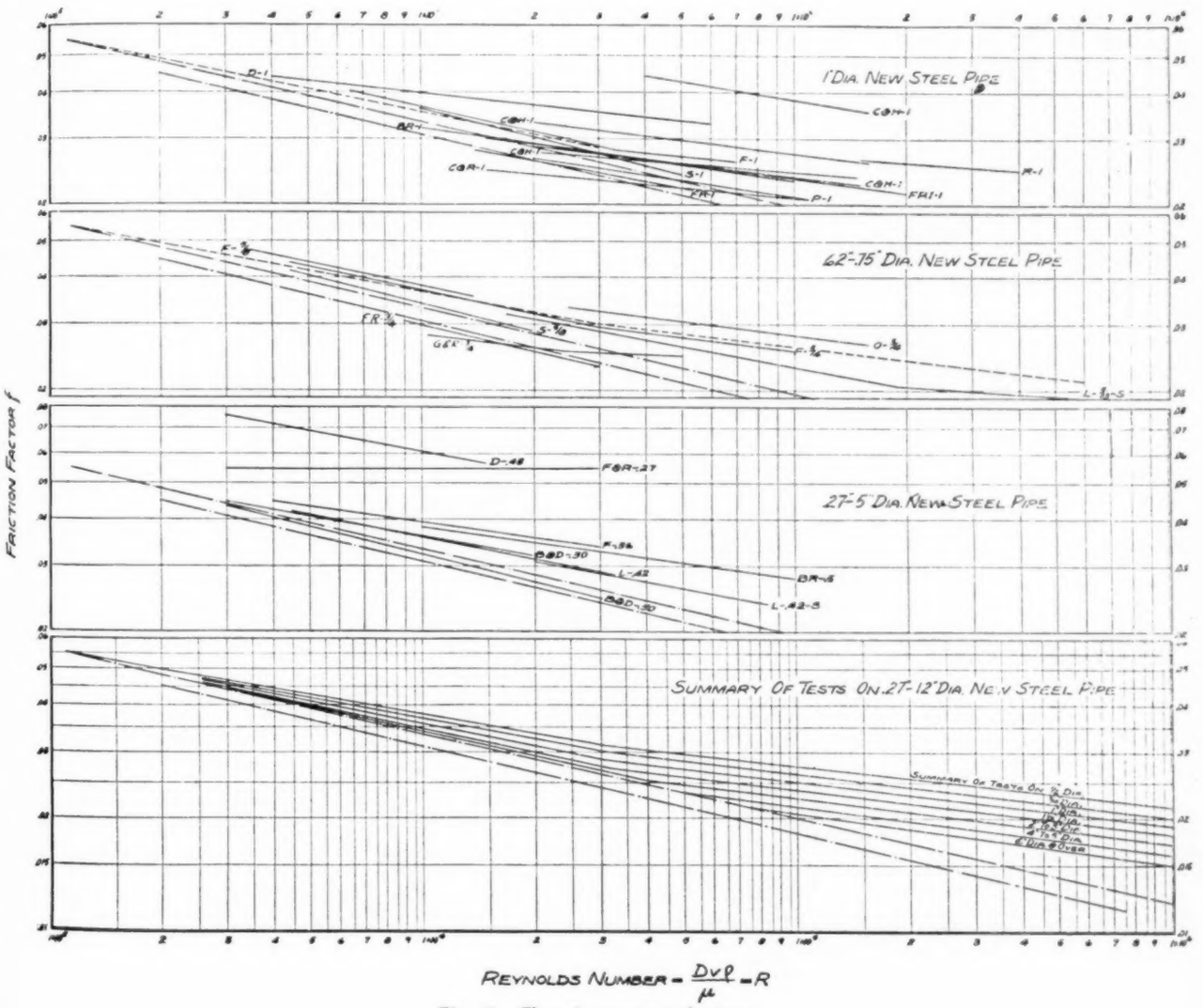
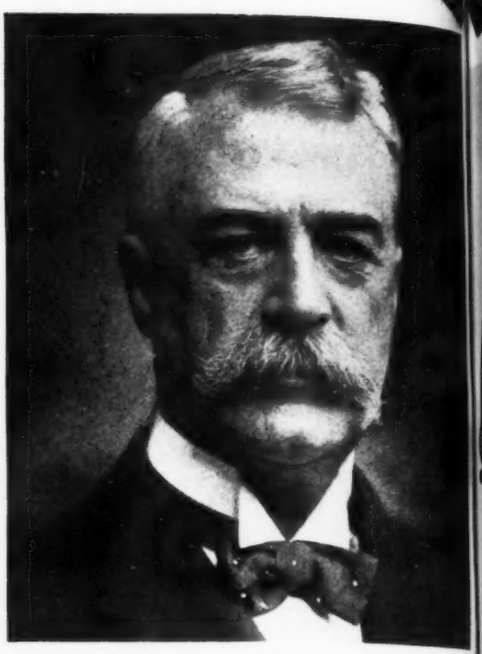

1" DIA. NEW STEEL PIPE
.62"-.75" DIA. NEW STEEL PIPE
2.7"-5" DIA. NEW STEEL PIPE
SUMMARY OF TESTS ON 2.7"-12" DIA. NEW STEEL PIPE
FRICTION FACTOR f
REYNOLDS NUMBER = $\frac{Dv\rho}{\mu} = R$

Fig. 2. Flow in new steel pipes

1859 PIONEERS TOGETHER 1862

Col. Edwin L. Drake, who drilled the first producing oil well—

1859



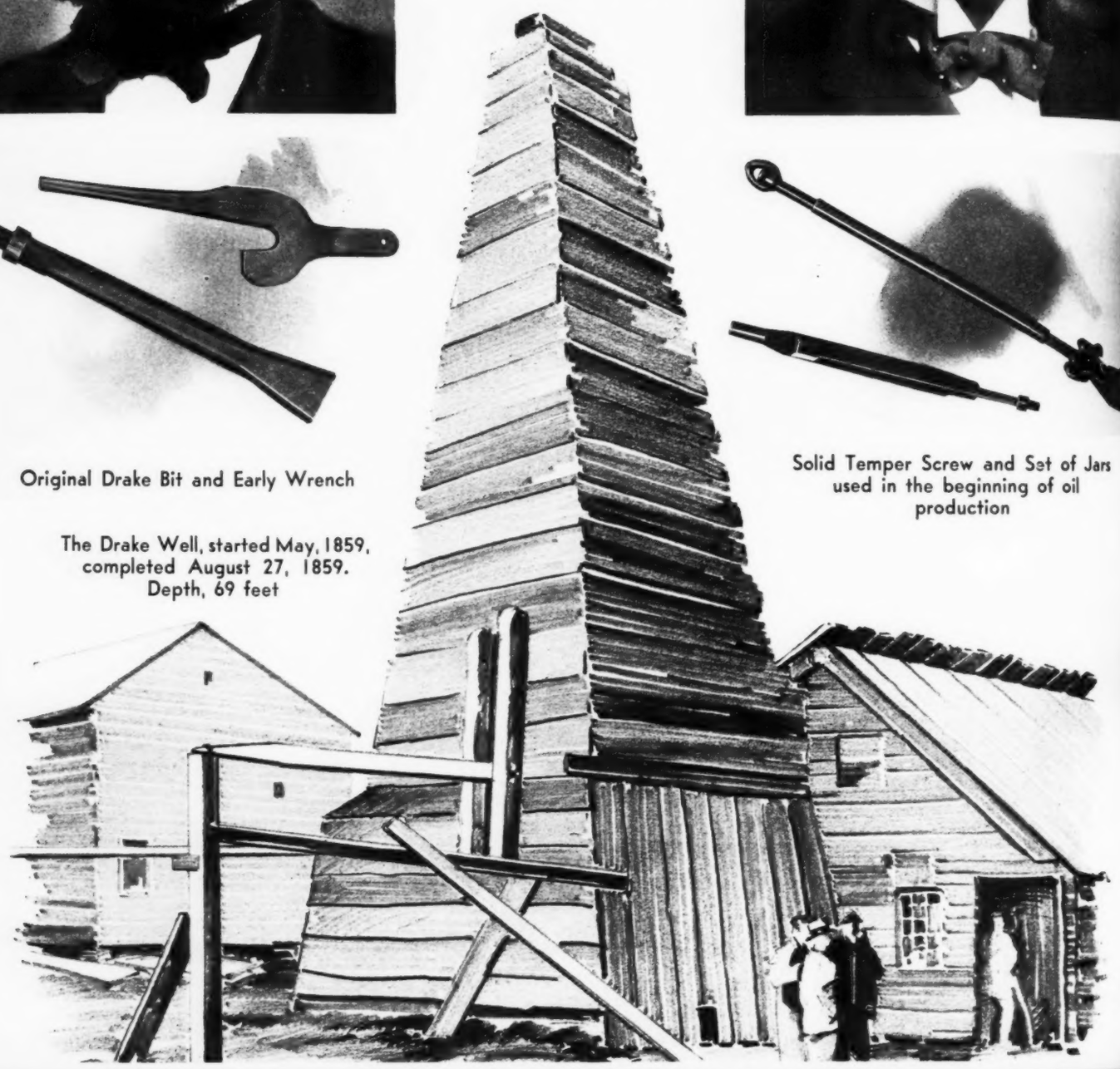
John Eaton, the founder of the Oil Well Supply Co.—

1862

Original Drake Bit and Early Wrench

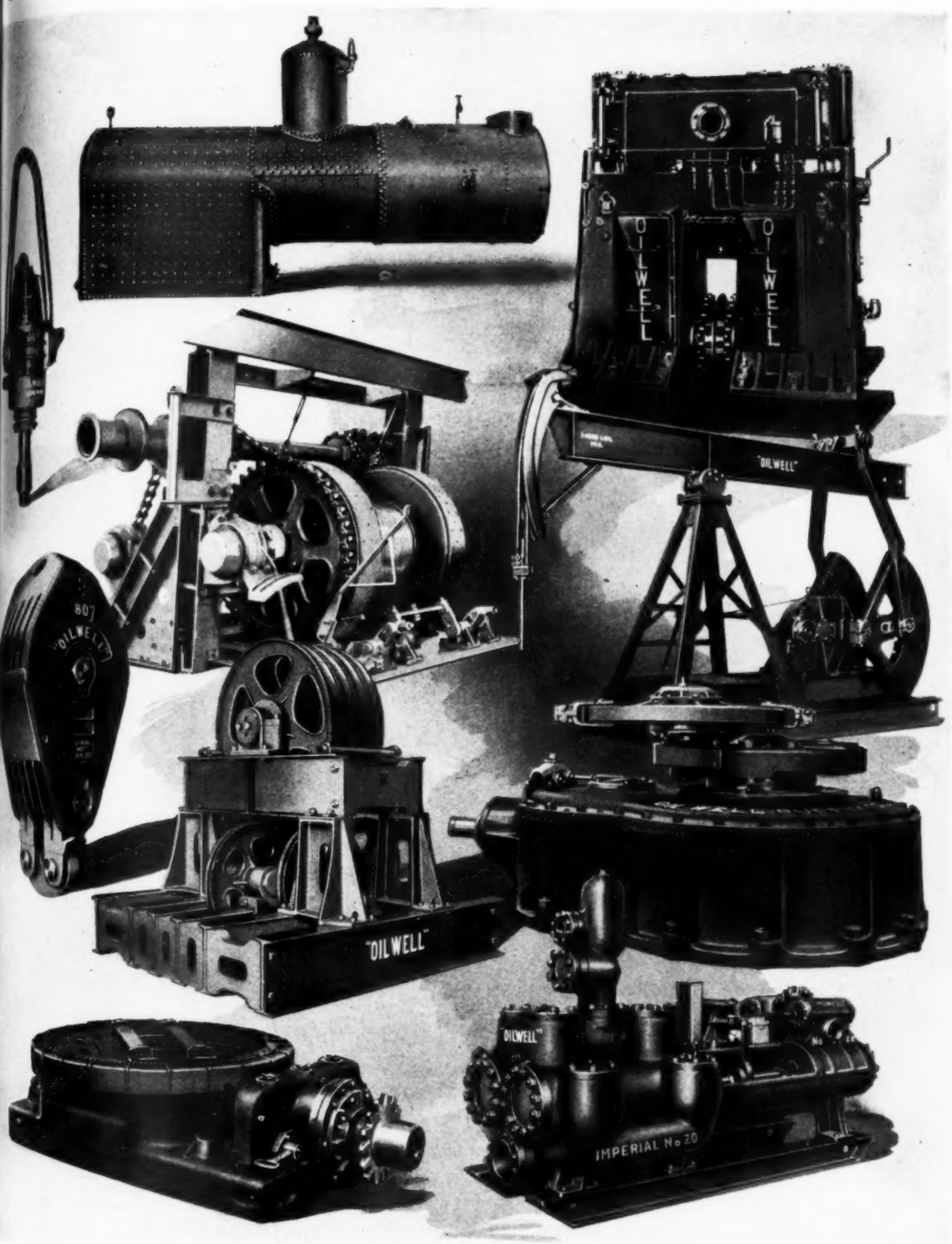
Solid Temper Screw and Set of Jars used in the beginning of oil production

The Drake Well, started May, 1859, completed August 27, 1859. Depth, 69 feet



OILWELL

1862 LEADERS TODAY 1934



• Pictured on these pages are tools of the early '60s and the modern heavy-duty "Oilwell" machinery. They bridge the span of three-quarters of a century of progress. They show the seventy-two years of progressive development of "Oilwell" resulting from constant engineering field studies, diligent laboratory research and thorough shop and field testing.

IT'S FROM "OILWELL" here's your guarantee

THE completion of the Drake Well, August 27, 1859, marks the birth of the petroleum industry. Only three years later, in 1862, a new business, the Oil Well Supply Co., was founded by John Eaton.

Thus Colonel Drake and John Eaton were pioneers in the inception and early development of a new industry.

"Oilwell" is proud of its connection with the petroleum industry since the beginning and is more proud of its contributions toward the economical recovery of oil under conditions which have been increasingly difficult.

"Oilwell" pledges a continuance of its best efforts to serve the industry no less fully now than in the seventy-two years past.

OIL WELL SUPPLY CO. *Branch Stores in all Oil Fields*

SUBSIDIARY OF UNITED STATES STEEL CORPORATION

2703

"OILWELL"

BAROID
(Extra-Heavy Colloidal Drilling Mud)

AQUAGEL
(Trouble-Proof Colloidal Drilling Mud)

STABILITE
(An Improved Chemical Mud Thinner)

. . . Contributors to Technical Progress

Laboratories in Los Angeles and Houston . . . Service Engineers in or near all important oil fields.

PROGRESS in the manufacture and use of mud conditioners has kept pace with progress in drilling methods and equipment.

Baroid Sales Company, through persistent research in laboratory and field, has contributed to this progress with BAROID, AQUAGEL and STABILITE—each of which has been constantly improved and perfected to guard your drilling investment.

Stocks Carried in All Active Oil Fields

BAROID SALES CO.
LOS ANGELES • HOUSTON
National Pigments & Chemical Co.
St. Louis

quently, Reynolds number is written as $\frac{Dv}{\nu}$ where $\nu = \frac{\mu}{\rho}$ and is called the kinematic viscosity. For liquids, this form has many advantages but for gases, the form $\frac{Dv\rho}{\mu}$ is as convenient. The method of applying Reynolds number in this country is to plot experimental curves of f against $\frac{Dv\rho}{\mu}$ rather than try to find the function Φ, which is, in general, very complicated.

Reynolds, in his experiments, found that there were two types of fluid flow. These experiments were made by drawing clear water through a transparent tube and admitting a very small stream of highly colored fluid near the entrance of the tube. When the velocity is low the stream of colored fluid extended through the tube in a straight line without mixing with the water. As the velocity was increased it finally reached a value above which the colored stream would mix with the water and the tube would appear to be filled with colored liquid.

The first of these types of flow is called streamline or viscous flow. In this case, the pressure drop results from the energy necessary to move one streamline relative to another which is a result of the viscosity of the fluid. The velocity at which the type of flow changes is called the critical velocity and has been found to occur at a value of Reynolds number of between 1200 and 3000. Above this number the flow is turbulent and must be studied experimentally.

It has been shown, both theoretically and experimentally, that for streamline flow:

$$f = 64 \left(\frac{Dv\rho}{\mu} \right)^{-1} = \frac{64}{R}$$

Then for any type of flow below a Reynolds number of 1200 the pressure drop can be calculated from:

$$dP = \frac{64\ \mu\ l\ v}{2gD^2}$$

For turbulent flow the value of f is not so well defined. As yet, no theoretical method has been developed to calculate with any degree of accuracy the friction factor for turbulent flow. It is, therefore, necessary to depend entirely upon experiment to determine the variation of f with Reynolds number for turbulent flow. Figs. 1 and 2 show a summary of all the data available in the literature on new steel pipes. In each of the figures the tests are grouped according to size. The double dot-dash line shows the range of values found for smooth pipes and the dashed line shows the average for each size. These averaged lines have been summarized in Fig. 2. Table 1 gives the experimenter, source of data, and some brief comments. The letters on the curves refer to the experimenter (see Table I) and the number to the pipe size in inches. The figure for 1.37-1.62-in. diameter new steel pipes shows some very interesting facts. The curve marked K & K 1.28 is for oil, G & L, 1⅜ is for brine, L-1.3 is for water, L-1.3-5 is for steam, and F1⅜ is for water. These test curves are all seen to be practically on one line, showing that the friction curve when plotted against Reynolds number is independent of the fluid flowing. The curves for .27-5-in. pipe sizes in Fig. 2 also show this. The curve marked F & R .27 was taken using both water and air and the curve L.42 was for water and L.42-S was for steam. The fact that the friction curve is independent of the fluid flowing when plotted against Reynolds number is very important. It permits data found for one fluid to be used for any fluid whatsoever.

TABLE 2—SELECTED LOCATION OF f BY ROUGHNESS RELATION

Curve	1	2	3	4	5	6	7	8		10	11	12	13	14	15	16	17	18
Roughness, per cent	0.2	0.45	0.81	1.35	2.1	3.0	3.8	4.8	6.0	7.2	10.5	14.5	19.0	24.0	28.0	31.5	34.0	37.5
	0.35 up	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.125	.....	.....	.....	0.0625
A	72	48 to 66	14 to 42	6 to 12	4 to 5	2 to 3	1½	1 to 1¼	¾	½	⅜	¼	⅛	.....	.....	.....	.....	.....
B	.....	.....	30	10 to 24	6 to 8	3 to 5	2½	1½ to 2	1¼	1	¾	½	.....	⅜	.....	¼	.....	⅛
C	.....	.....	48 to 06	20 to 48	12 to 16	5 to 10	3 to 4	2 to 2½	1½	1¼	1	.....	.....	.....	.....	.....	.....	.....
D	.....	.....	96	42 to 96	24 to 36	10 to 20	6 to 8	4 to 5	3	.....	.....	.....	.....	.....	.....	.....	.....	.....
E	.....	.....	220	84 to 204	48 to 72	20 to 42	16 to 18	10 to 14	8	5	4	3	.....	.....	.....	.....	.....	.....
F																		

A = Drawn tubing, brass, tin, lead, glass, diam., in. B = Clean steel, wrought iron, diam., in. C = Clean, galvanized, diam., in. D = Best cast iron, cement, light riveted sheet ducts, diam., in. E = Average cast iron, rough-formed concrete, diam., in. F = First-class brick, heavy riveted, spiral riveted, diam., in. In drawn tubing, actual inside diameter is given. In pipe, nominal size of standard weight is given.

A complete discussion of the curves shown in the above figures, together with curves for all kinds of rough pipe, are given in the paper by Emory Kemler on "A Study of the Data on the Flow of Fluids in Pipes," A.S.M.E., Hydraulic Transactions, Vol. 55, No. 10, August 31, 1933.

While these data are satisfactory for new pipes they do not cover the entire range desired in practice. As stated earlier, Pigott has generalized these data and applied them to all kinds and sizes of pipes. A summary of his work is given in Table 2 and Fig. 3. From this table and figure the friction factor can be found for any size and kind of conduit. These curves represent the best available data on the determination of the friction factor for rough pipes that have been published and have been found to work very well for the solution of practical problems. A complete discussion of these curves and the means by which they were arrived are given in Pigott's paper on "The Flow of Fluids in Closed Conduits," appearing in the August, 1933, issue of *Mechanical Engineering*. Pigott also takes up in detail the question of pipe roughness and how it affects fluid flow. This is a most important question and one that has been given little attention.

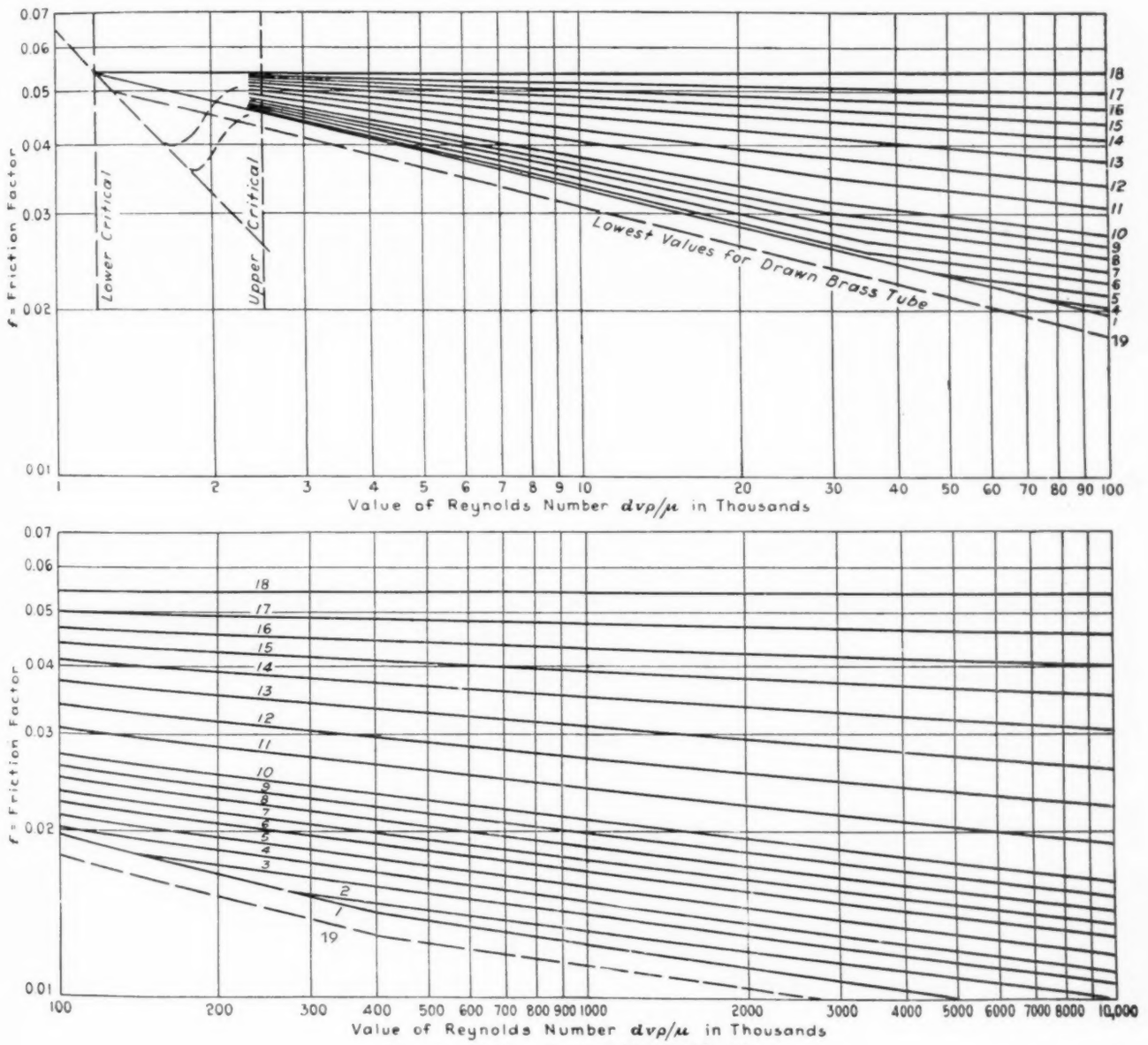
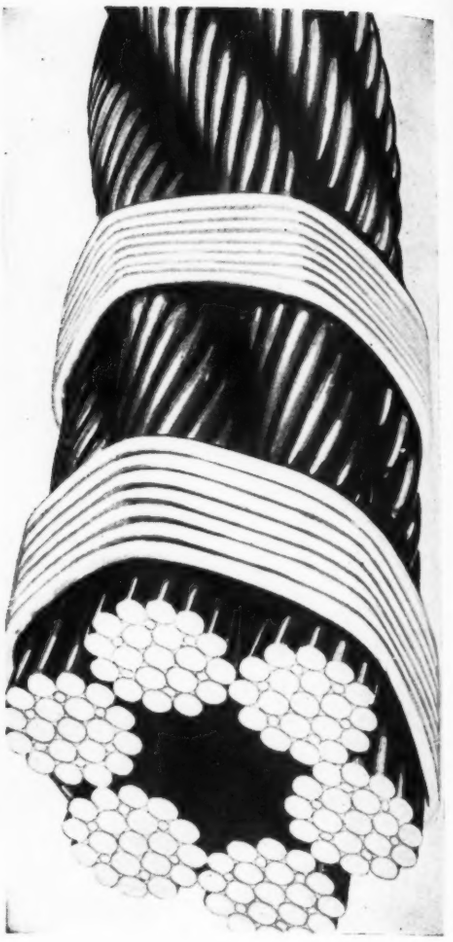

f = Friction Factor
Lower Critical
Upper Critical
Lowest Values for Drawn Brass Tube
Value of Reynolds Number dvρ/μ in Thousands
f = Friction Factor
Value of Reynolds Number dvρ/μ in Thousands

Fig. 3. Friction factors (See Table 2)



When cutting Wire Rope Seizing is important!

Know your Ropes ...This is a helpful hint, how to make wire rope last longer. Subsequent Wickwire Spencer advertisements in this publication will give other dollar saving information. Tell us about your rope problem and we will give you the answer.

Preformed as well as standard lay wire ropes should be properly seized before cutting. Inadequately or loosely bound ends result in distortion and flattening when cut. Such distortion loosens the strands at both cut ends. When a rope so mutilated is later attached and put in tension by use, the load is borne unequally by the several strands within the rope. Tight, adequate seizing prevents this flattening and distortion. It gives a rope its rightful chance of long life. Because every part of the rope may be loaded equally, every strand is permitted to do its share of the work.

WICKWIRE SPENCER STEEL COMPANY, New York City, Buffalo, Chicago, Worcester; *Pacific Coast Headquarters:* San Francisco; *Warehouses:* Portland, Los Angeles, Seattle. *Export Sales Dept.,* New York City.

WIRE ROPE by Wickwire Spencer

BOTH...STANDARD LAY AND WISSCOLAY PREFORMED.

Wickwire Spencer manufactures all sizes and types of Wire Rope in standard lays and preformed. Wisscolay preformed wire rope will often solve a wire rope application difficulty. Ask our engineers where and when it should be used. Send for a free WIRE ROPE BOOK. It will prove of great value.

Elements of Applied Petroleum Production

By K. C. SCLATER

Article 10

Gas-Lift Wells (Continued)

EQUIPMENT AND OPERATION OF OIL WELLS (Continued)

GAS-OIL RATIO (continued). The quantity of inlet gas required in a gas-lift well per barrel of oil produced will depend upon well operating conditions. A decline in the daily rate of oil production should also cause a decrease in the daily volume of inlet gas required at the well. It is not enough to know that the daily inlet gas requirements are decreasing. It is important to know also whether the inlet gas-oil ratio is increasing or decreasing, and what are the well operating conditions that are most likely to affect this ratio.

If the daily production of the well declines at a faster rate than was estimated when the flow string was designed, the inlet gas-oil ratio may increase. It all depends on the design of the flow string and how closely it meets the well conditions. If the diameter of the flow string, when installed, is too small for the producing capacity of the well, a decline in the daily rate of oil production may result in more efficient flow, and as a possible result, a decrease in inlet gas-oil ratio. On the other hand, if the diameter of the flow string, when installed, exactly meets the well's producing capacity, a decline in the daily rate of oil production may result in a decrease in the efficiency of the flow, and as a possible result, an increase in the inlet gas-oil ratio. The latter case probably happens more frequently in actual practice than the former. In the former case, the flow string design would be such that a more efficient flow would be obtained as the rate of oil production declined, thus giving a possible increase in inlet gas-oil ratio; but a point would eventually be reached that the producing capacity of the well would not be sufficient for efficient flow and a possible increase in the inlet gas-oil ratio might result. Miller[47] found wide limits between the volume of gas circulated for various volumes of gas produced in a group of wells in California, as shown in Table 3. He observed that in some wells the size of flow string was too large for the daily rate of production, and draws attention to the fact that "as most of the cost of lifting oil by the gas-lift method is the cost of compressing the gas circulated in the wells, it is important that the ratio of gas circulated to oil produced be as low as possible."

Even if the cost of compressing the gas is not an important item, there are other reasons why the inlet gas-oil ratio should be held to the proper amount. The amount of inlet gas circulated will influence the formation gas-oil ratio and also the oil production. The proper volume of inlet gas is that giving the highest daily rate of oil production with the lowest formational gas-oil ratio. This will result in the highest ultimate oil recovery. It is therefore important to control the volume of inlet gas to this amount.

Although the volume can be changed by adjustments in the flowing pressure, a test may reveal that the limits within which the inlet gas can be controlled will not give a reasonably low inlet gas-oil ratio. The volume of inlet gas required may still be too high to be economical. In that case it may be necessary to change the size, or the length, or both, of the flow string. In general, it may be said that if the daily rate at which a gas-lift well is being produced is less than its maximum productive capacity, the daily rate of flow can be increased by increasing the volume of inlet gas. But if the well is already producing at its maximum capacity, an increase in inlet gas volume will only result in a decrease in daily rate of production, or in other words, the inlet gas-oil ratio will increase.

The cost of compressing the inlet gas may not have to be considered; for example, where high-pressure gas from other wells is available. In that case the proper volume of inlet gas is usually that which results in maximum daily rate of production, and minimum formational gas-oil ratio only. If the cost of compressing the gas must be considered, then the proper volume of inlet gas will usually be that which results in the lowest formational gas-oil ratio and also the minimum gas-oil ratio at the maximum daily rate of oil production. In both of these cases it is assumed that there is no limit on the daily rate of production and that the well should be produced at its maximum rate of flow at the minimum gas-oil ratio.

Where the desired daily rate of oil production is less than the maximum productive capacity of the well, and the cost of compressing the gas has not to be considered, the proper volume of inlet gas is that which results in the lowest formational gas-oil ratio at the desired rate of production. If the cost of compressing the gas must be considered the proper volume of inlet gas will be governed by the cost of com-

pression and not altogether by the lowest formational gas-oil ratio at the desired rate of production. The volume of inlet gas required to obtain a low formational gas-oil ratio may be so great that the total cost of compression will be prohibitive. In that case it may be economical to reduce the volume of inlet-gas at the expense of an increase in the formational gas-oil ratio at the desired rate of oil production.

Due to the limitations imposed on a well under actual field operating conditions it is seldom possible to alter the size and length of the flow string to meet the changing well conditions. The best that can be done is to strive to maintain the operating conditions in the well as efficient as circumstances will permit. A compromise usually has to be effected that involves sacrificing mechanical efficiency. So it is in controlling the inlet gas-oil ratio. In a gas-lift well, it is the most important ratio influencing the well operation. Its regulation and control, as is evident from the foregoing discussion, will depend not only on the well conditions, but also upon whether the cost of compression has to be considered.

It is well to note the distinction between an increase in daily inlet volume and an increase in the inlet gas-oil ratio. An increase in the volume does not necessarily mean an increase in the ratio. It is well also to note how the inlet gas-oil ratio may be changed, and when a change is made how the change influences the volume of inlet gas. We may use a flow string of a different size or length, or both, to obtain a change in the inlet gas-oil ratio; or if it is not feasible to make any of these changes we may use a flow bean, which induces pressure changes in the well. These pressure changes affect the pressure at the face of the sand, as well as in the flow string, and thus cause a change in rate of oil production and the formational gas-oil ratio. When any changes are made in the flow string it also involves pressure changes at the face of the sand. Thus by observing and checking the gas-oil ratios, we have a means of checking well operation. We also have an indicator of flowing pressures in the well.

FLOWING PRESSURE. When thinking of flowing pressures in a well, it is of great help to try to interpret them in terms of the pressure at the face of the sand. It is now considered good practice in flowing gas-lift wells to use gas at a pressure not to exceed 250 to 300 pounds. Compressed gas at this pressure can usually be made available at natural gasoline plants where the compression system is used. In deep wells, however, pressures as high as 500 lb. may be needed. It is seldom that a pressure higher than 500 lb. is employed when the gas has to be compressed.

There are several operating pressures in a gas-lift well with which we are concerned. These are: the pressure at the gas inlet on the well head; the pressure at the bottom of the flow string; the pressure at the top of the flow string; and the pressure at the face of the sand. Since, as has been emphasized repeatedly in this series of articles, the rate of oil production is dependent only on the pressure at the face of the sand, any changes in the well flowing pressure should be interpreted in terms of the effect produced on the face of the sand. Too high a pressure at the gas inlet may put an excessive pressure on the face of the sand and retard the flow of the well.

Of the operating pressures, the pressure at the face of the sand and that at the bottom of the flow string cannot be read from the surface. An indication of whether they are too high or too low can be observed from the flow and behavior of the well.

The pressures at the bottom and top of the flow string will depend upon the size and length of the flow string itself, the density, viscosity and surface tension of the oil, and the outlet gas-oil ratio (the inlet gas plus the formation gas divided by the oil production). Between the bottom and the top of the flow string the average pressure drop for oil of average gravity and for the average sizes of tubing in general use (2-in. to 3-in.) is roughly 10 lb. per 100 ft. in actual practice. It will, of course, vary in amount per 100 ft. several pounds higher or lower than this, depending upon the design of the tubing string and also upon the gravity of the oil. Heavy viscous oils will have a higher friction loss when flow-

TABLE 3

The average of the maximum, the average of the minimum, and the average volumes of gas circulated daily in 30 gas-lift wells in California for various rates of oil production and the corresponding inlet gas-oil ratios.

(Wells were being produced under average gas-lift operating conditions through about 4000 ft. of 3-in. tubing. Average gravity of oil 24 deg. A.P.I.)

Daily Oil Production	MAXIMUM		MINIMUM		AVERAGE	
	Daily Volume of Inlet Gas	Inlet Gas-Oil Ratio	Daily Volume of Inlet Gas	Inlet Gas-Oil Ratio	Daily Volume of Inlet Gas	Inlet Gas-Oil Ratio
Bbl.	Thousand Cu. Ft.	Cu. Ft. Per Bbl.	Thousand Cu. Ft.	Cu. Ft. Per Bbl.	Thousand Cu. Ft.	Cu. Ft. Per Bbl.
50	550	11000	50	1000	175	3500
100	585	5850	60	600	200	2000
200	660	3300	100	500	275	1375
300	750	2500	150	500	350	1166
400	875	2190	220	550	450	1125
500	1000	2000	300	600	550	1120
600	1150	1910	420	700	700	1166
700	1400	2000	550	786	850	1215
800	1800	2250	800	1000	1100	1375

ing and hence will require a higher flowing pressure than the lighter oils.

When the flowing conditions in a gas-lift well are steady, the difference in pressure between the formation (the reservoir) and the face of the sand will be fairly constant over a period of time. Actually, however, the formation pressure declines as the oil and gas are withdrawn, and the difference in pressure between the formation and face of the sand gets smaller. In order to maintain the rate of oil flow into the hole, therefore, the pressure at the face of the sand must be reduced. This is usually done by means of a flow-bean at the top of the flow string or by an adjustment in the length of the flow string.

Where the inlet and outlet gas volume are measured by orifice meter on a gas-lift well that flows steadily, pressure readings are obtained from the meter charts. These gas volume measurements are not always taken daily, especially if conditions in the well do not fluctuate, instead, check readings are taken only at intervals. Pressure gauges, however, should be used on the gas-inlet and on the flow-line outlet lines. If the gas separator is close to the well, the pressure readings on the separator may be used instead of the flow-line pressure.

CASINGHEAD CONNECTIONS. Equipping a gas-lift well with surface connections lends itself to a wide variety of arrangements. Whether an elaborate christmas tree, if such is necessary, or the simplest type of connection, the design of casinghead connections is a matter of making provisions for contingencies so that the flow will not have to be unnecessarily interrupted or shut-down after the well is in operation.

The casinghead connections may be very elaborate or very simple, depending upon whether or not it is a high-pressure well and the degree of control required. They comprise: a gas-inlet connection, an outlet or flow-line connection, and the necessary control valves and fittings. If there is any likelihood that it will be necesary at any time to reverse the flow of the well, both the casing and tubing should be equipped with a gas-inlet line and an outlet or flow-line connection. Duplication of connections in this manner is quite common, and in most cases is advisable on a high-pressure well even though the need to reverse the flow may not be apparent when the well is equipped for gas-lift.

Starting and control valves should be conveniently placed with respect to shut-off valves. As in a naturally flowing well, the space between the casing and tubing should be packed off securely with an approved type of packing head capable of withstanding the highest starting pressure required at the well.

A well that has to be swabbed to start the flow, should have a connection on the tubing extending above where the flow-line goes off to the separator.

The flow line between the trap and separator should be no larger in diameter than necessary, and be free from abrupt bends. Sharp bends create turbulence and cause separation of the gas and oil, thus reducing the efficiency of the flow between the well head and the separator. In small wells that are very sensitive to changes in pressure, the detrimental effects are most marked. Gate valves or stop cocks should be used in preference to globe valves. The latter, like abrupt bends, destroy the stream-line flow.

SEPARATORS. In Article 5 (March, 1934) of this series, the discussion on separators for naturally flowing wells applies also to gas-lift wells.

An important consideration in regard to separators for gas-lift wells is that they should be set close to the well. If they are some distance away, it entails a long flow line, which may set up a back-pressure at well head and seriously reduce the efficiency of flow. This is especially the case where small wells, or wells sensitive to pressure changes are concerned.

Separators on gas-lift wells are frequently subjected to pressures much higher than the normal working pressure. When the well is started, especially if "rocking" is resorted to, there may be a sudden rush of high-pressure gas in large volume. In selecting a separator for gas-lift work, this contingency has to be taken into consideration. Separators vary widely in their internal arrangements for accelerating the liberation of the gas from solution in the oil. The surface tension of the oil governs the ease with which the gas is liberated. Oils of high surface tension (generally the light oils) liberate the gas in solution with greater ease than the oils of low surface tension (generally the thick viscous oils). Hence, when considering the capacity of a separator for a gas-lift well, this fact must be kept in mind. A separator that is capable of giving thorough and rapid separation will have a greater capacity than another separator of similar dimensions that gives less thorough and slower separation.

When water is produced with the oil in a gas-lift well, emulsions may be formed. The rate of gas liberation, in such cases, is usually retarded and the capacity of the separator system impaired.

QUESTIONS

1. Give one or more reasons why the inlet gas-oil ratio of a well produced by gas-lift might not be affected by a decrease in the volume of inlet gas.

2. Assume that a well has recently been put on the gas-lift and is flowing steadily with no appreciable change in the volume of pressure of the inlet gas, what might cause the gas-oil ratio gradually to decrease before starting on a normal upward trend?

3. Explain why an increase in the inlet gas volume might cause the oil production to drop in a gas-lift well.

4. Under what conditions would it be economical to reduce the volume of inlet gas at the expense of an increase in the formational gas-oil ratio in a gas-lift well?

5. Name two or more important considerations concerning the installation of surface flow lines on a gas-lift well.

6. Why might the appearance of emulsion in the well impair the capacity of the well separator?

REFERENCES

[49]"An Investigation of the Air-Lift Pump," by G. J. Davis and C. R. Weidner, *Univ. of Wisconsin, Bull.* 667, Madison, Wis., 1914.

[50]"Response to Pressure Variation Important for Gas Life," by U. V. Thomas, *Nat. Petroleum News*, Nov. 9, 1927.

[51]"Relation of Air-gas Lift to Gas-oil Ratios and Effect on Ultimate Production," by F. W. Lake, *Petroleum Development and Technology*, 1927.

Elements of Applied Petroleum Refining

By W. L. NELSON
Consultant*

Article X

USE AND SPECIFICATIONS OF PRODUCTS (Continued)

FUEL OIL, RESIDUES AND LUBRICATING OILS

FUEL oil and residue materials are usually not of much market value. In fact it may cost more to produce them than they are worth. Nevertheless, they are produced during the manufacture of other products and they must be disposed of in some manner.

FUEL OILS. Two types of fuel oils are marketed. The *distilled fuel oils* are used for tractor fuel, Diesel engine fuel, furnace fuel for household and industrial heating systems, enrichment of manufactured gases, absorbing natural gasoline in gas recovery systems, and as industrial process fuels. The *residual fuel oils* contain all the tar that may be in the crude oil or cracking plant residue and hence they are dark-colored. They are used as boiler plant fuel, refinery fuel, locomotive fuel, steamship fuel, and for many industrial heating operations. The residual fuel oils are usually more viscous and have a higher pour-point, hence are not satisfactory for services, such as household heating, in which the burner is not carefully attended. In the Pennsylvania district the term fuel oil is used in referring to a distilled fuel, whereas Mid-Continent refiners refer to a residue fuel when they use the term fuel oil.

In general, all fuel oils must meet certain requirements. They must be free from grit and suspended material so that they will not clog the burner valve; they should not contain water; the pour-point must be high enough so that the oil will not freeze under the conditions of service; and they must have a flash-point that is high enough to avoid danger by fires or explosions. These specifications, except in rare cases, can be easily met.

The properties of some distilled fuel oils are shown in Table 6. The first three are specifications by the United States Government[1] but the others are average properties. Except for the light domestic fuel oil, the flash-point (Cleveland Open Cup) is usually above 170 deg. fahr. This is a safe flash-point for almost all conditions. The gravity is of little direct importance, but fuel oils are often marketed by gravity because the gravity can be easily determined. The viscosity of distilled fuels is always satisfactory but the pour-point is often a source of trouble. The end-point is automatically limited because the waxes are present in large percentages in the higher boiling oils. Large quantities of distilled fuel oil are sold each year, but by far the largest amount is used as a cracking stock. If this alternate method of disposal were not available the distillate fuel market would be ruined in a few days.

The residual fuel oils are even cheaper than the distilled fuels, but for industrial services in which a fireman is constantly in attendance they are equally satisfactory. The heating-value is a little better than for distilled fuels, but the difference is hardly worthy of note. The heating-value is directly related to the gravity unless the fuel contains abnormal amounts of sediment, water, sulphur, oxygen, or nitrogen. The relation of gravity to heating-value is shown in Fig. 23. This figure was taken from the data given in the government bulletin, "Miscellaneous Publication of the Bureau of Standards No. 97 (1929)." This bulletin contains such a useful accumulation of physical data that I wish to

*Professor of Petroleum Refining, University of Tulsa.

TABLE NO. 7

SAE No.	Viscosity Saybolt Universal Seconds at 100 deg. fahr.	130 deg. fahr.	210 deg. fahr.
10		90-120	
20	231-384	120-185	50-60
30	384-550	185-255	60-69
40	550-652	255-293	69-75
50	652-1244	293-397	75-105
60			105-125
70			125-150

TABLE 6
Properties of Distilled Fuel Oils

GRADE	Flash-Point Deg. f.	Deg. A.P.I.	Pour Point Max. Deg. F.	DISTILLATION I.B.P.	10%	Max.	Viscosity at 100	Water and Sed.
1. Light Domestic Fuel Oil	110-165	42	15	—	420	600	—	.05
2. Medium Domestic Fuel Oil	125-190	39	15	—	440	620°	—	.05
3. Heavy Domestic Fuel Oil	150-200	36	15	—	460	675*	—	.1
4. Diesel Fuel Oil (Aero)	150-180 (O.C.)	38-43	30	380	490	600	32	None
5. Gas Oil (Gas Manufactured)	195	36	—	302	460	700 +	35	—
6. Industrial Fuel Oil (st. run)	175-265	26-35	35	420-480	450-500	800 +	41-50	—
7. Absorption Oil	265	35.5	—	536	572	698	41	.05
8. Straw oil	275 and higher	34 +	30	530	—	—	70 or less	—

*90 per cent point.

call particular attention to it. Fig. 23 may be used for either distilled or residual fuel oils. Three residual fuel oils are specified by the government. These are shown in Table 7. Residual fuel oils usually have a flash-point exceeding 200 deg. fahr., a furol viscosity at 122 deg. fahr. of about 100, a pour-point not over 40 deg. fahr., and the gravity may range from 6 to 27 A.P.I. Sulphur is usually limited to 1.5 per cent and water and sediment to one per cent.

The success in firing an oil is more closely related to the atomization that can be obtained in the burner than to any other factor. The viscosity affects the atomization properties more than any other physical property of the fuel, barring the presence of sediment and water. Straight-run fuel oils are much more viscous than cracked fuel oils of the same gravity and hence a low-gravity straight-run fuel oil must usually be heated. A straight-run fuel of 11 A.P.I. gravity may need to be heated to 240 deg. fahr. to obtain proper atomization, although a cracked fuel oil of 11 A.P.I. gravity will usually be fluid enough to require no heating. The amount of steam that is required to atomize viscous fuels is high so that it usually pays to heat a viscous oil rather than depend upon steam.

A fuel oil may be a road oil as well as a fuel oil. Road oils are viscous residual oils that contain 40 to 85 per cent of 100-penetration asphalt. Other properties are specified but they are usually easy to obtain. The wide range of asphalt content is due to the many different state specifications. Other properties that are specified are: specific gravity, Furol viscosity, solubility in carbon disulphide and petroleum ether, flash-point, evaporation loss, and ductility of the asphalt content. In addition to straight-run road oils, cut-back road oils are manufactured by blending asphalt and gas oil. These cut-back oils dry quickly.

ASPHALT. The methods of manufacturing asphalt have undergone a great change during the last few years. Asphalt was originally manufactured by steam distillation and by blowing with air. These methods have been largely superseded by vacuum distillation although air-blowing is still practiced. Vacuum distillation has permitted a wide range of stocks to be processed for asphalt. Notable among these, are cracking-still residues.

Asphalt is used for such a wide variety of purposes that a clear discussion is difficult. It is used for pavements, as a grout filler for cracks in pavements, for mastic foot pavements and floors, as a roofing material, as a saturate for felt and paper, for waterproofing concrete or protecting pipelines, for sealing pipe connections (sewer pipe), and as a constituent of asphalt paints. Obviously a large range of specifications is required to cover these many uses. The properties that are of greatest importance are the penetration, ductility, and melting-point. The hardest asphalts have a penetration at 77 deg. fahr. (for five seconds with a load of 100 grams) of 10 and the softest asphalts, such as those used in cold climates for macadam roads, have a penetration of 150. Softer materials are classed as semi-solid bitumens and their consistency is usually determined by the float test. The ductility that is required in road asphalts seems to be increasing each year. It is now common to demand a ductility of 100 centimeters plus. A classification of asphalts according to penetration is given in Table 8.

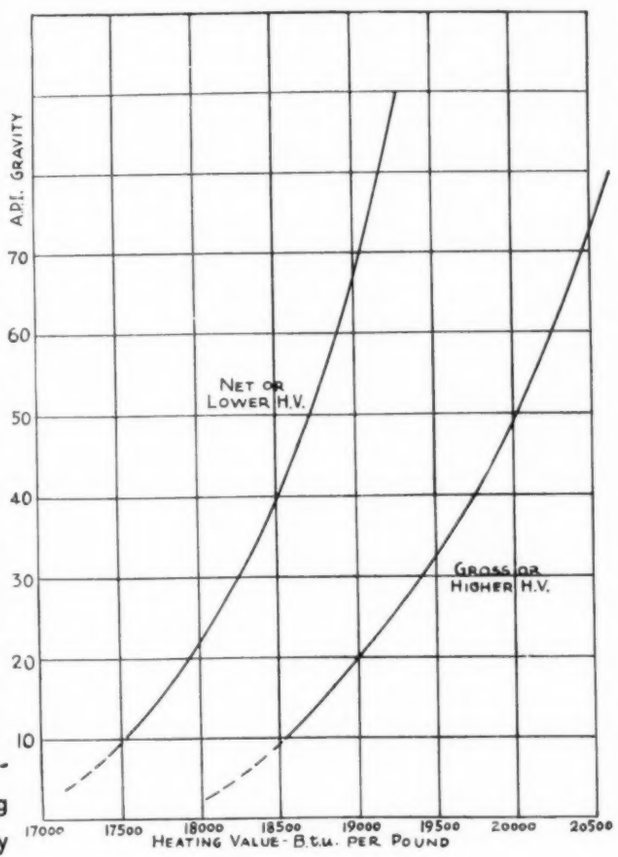


Fig. 23. Relation of heating value to A.P.I. gravity

PETROLEUM COKE. Petroleum coke is used for many special purposes such as the manufacture of carbon electrodes, brushes and plates, in the manufacture of calcium carbide, in gas manufacture, and as a metallurgical fuel, but its main use is as a powdered fuel for stills, boiler plants, and heating systems. It has a high heating-value, contains only a small amount of ash or clinker-forming substances, and some cokes contain only a small amount of sulphur. The difficulty with many coking processes is the production of a coke that does not contain too much volatile matter. A coke containing more than about seven per cent of volatile matter tends to smoke and deposit soot.

The average properties of petroleum coke are as follows:

Apparent density	0.9 - 1.1
Color	Dark brown to gray black
Moisture	0.2 - 0.4
Ash	0.1 - 2.0
Sulphur	0.5 - 1.3
Volatile Matter	5 - 16 per cent
Fixed Carbon	80 - 90 per cent
Heating Value	15,000 - 15,500 B.t.u. per lb.

LUBRICATING OILS. The wide usefulness of mineral lubricating oils does not permit a discussion of all of them. Among these oils are motor oils, tractor oils, aero oils, gun and ice-machine oils, engine and machine oils, chain and wire-rope oil, penetrating oil, transmission oil and technical white oil. Technical white oil is particularly interesting because it is used to lubricate machinery in bakeries, candy factories and textile mills. Colored oils cause stains and discolorations that cannot be permitted.

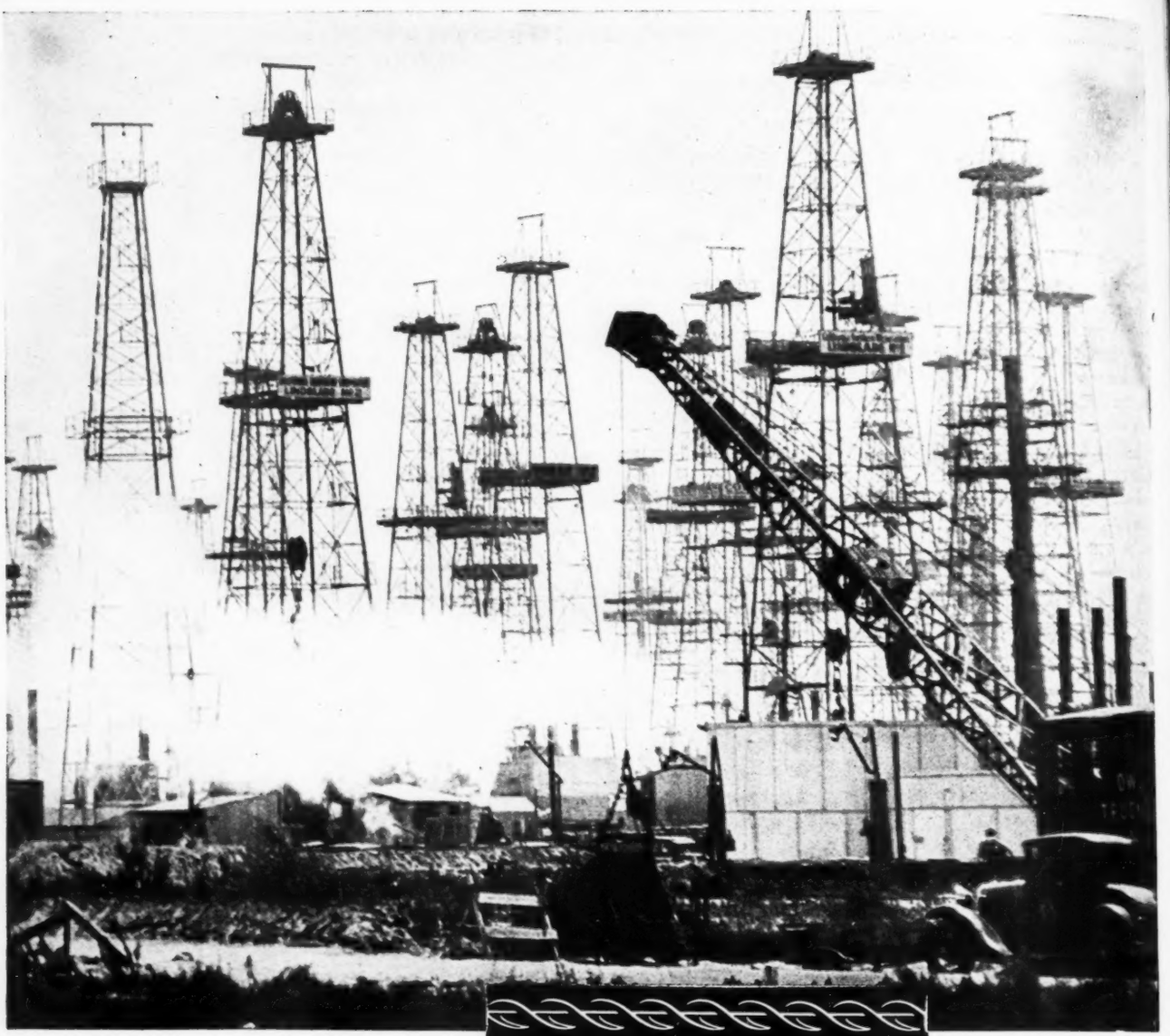
The government specifies four classes of lubricating oil.

Class A: For lubricating machinery and engines when a highly refined oil is not necessary. Not for steam engine lubrication. Five grades: extra light, light, medium, heavy, and extra heavy.

Class B: For lubricating turbines, dynamos and high-speed steam engines using circulating or forced-feed lubricating systems. Five grades of viscosity.

Class C: For lubricating when service conditions necessitate an oil suitable for both turbine and internal-combustion engine lubrication. Five grades of viscosity.

Class D:[2] For lubricating internal-combustion engines except aircraft and Diesel engines. (Special oils required). Nine grades of viscosity, including those in Classes A, B and C,



THE SPIRIT OF ACHIEVEMENT

Thermoid products are engineered with the same spirit of achievement that has drawn the raw products from the earth . . .

Thermoid
MECHANICAL RUBBER GOODS
QUALITY VALUE SERVICE
IT'S FROM "OILWELL"

Precious stones, metals, *oils* yield to man's ingenuity. They are drawn forth to serve their purpose in the specialized world of today. In the progress of these great industries, Thermoid products are assuming each day a greater and greater responsibility.

Beltings, hose, brake linings, packings—all must be of dependable and lasting quality. Each one must be specifically fitted to the task assigned. All must reflect the advantages of experience and the knowledge of the progressive engineer. Only by living up to the highest principles of manufacture has the name THERMOID become accepted as a standard of quality. *Buy by that quality mark!*

OIL WELL SUPPLY CO.

Branch Stores in all Oil Fields. Distributors of

Thermoid

PRODUCTS FOR THE OIL INDUSTRY

Including Oil Pumping and Oil Drilling Belt — Rotary Hose — Air, Steam, Welding and Refinery Hose — Packings and Brake Lining

TABLE 8

Classification of Asphalts by Penetration

	Penetration at 77° F.	Ductility at 77° F.	Melting Point R & B
Paving Binders:			
Mastic foot pavements and floors	10-15	—	180-220
Asphalt blocks	10-25	20+	.....
Sheet asphalt pavement	25-40	40+	105-140
Grout filler	40-70	50+	113-140
Grout filler (blown type)	30-50	3+	150-230
Asphalt concrete (aggregate sand, etc.)	30-70	45+	113-150
Asphalt macadam	70-150	90+	104-113
Roofing Asphalts:			
Saturant for felt or paper	75-140	100+	110-120
Heavy saturant for felt and rugs	28-32	40+	140-150
Roof coatings (blown)	10-50	1+	160-260
Sealing:			
Pipe sealing (sewers, etc.)	40-60	1+	200-225
Pipe coatings	10-15*	1+	200-215
Waterproofing	25-50	15+	140-170

*Consistency.

and in addition, ultra heavy, tractor heavy, and motorcycle.

The characteristic difference in the four classes are: Class A, reaction and corrosion; Class B, emulsion and demulsibility; Class C, neutralization, demulsibility, and carbon residue; and Class D, neutralization, viscosity-temperature relation, and, for the heavier oils, carbon residue.

This somewhat elaborate system of classification has been largely replaced in the industry by the number classification proposed by the Society of Automotive Engineers.

The SAE numbers are now widely used in marketing lubricating oils. Even the public has become aware of this number system and the filling station operator frequently has calls for lubricating oil by the SAE number.

The important common tests for an oil are: (1) flash and fire points, (2) viscosity and viscosity-index, (3) color, (4) pour-point, (5) corrosion, (6) emulsibility and demulsibility, (7) carbon residue, and (8) precipitation.

The flash-and-fire-points indicate the amount of light material (gas oil) in the lubricating oil. Naphthene-base oils usually have lower flash-points than other oils. Low-flash oils tend to be distilled into the exhaust of an automotive engine. However, the effect of the flash-point on lubricating ability should not be over-emphasized because a low-flash oil always exists in the engine after a few miles of operation, owing to crankcase dilution. Thus, a high-flash oil soon becomes no better than any other oil except for the smaller loss in the exhaust gases. The flash-point is widely used as an indication of the degree of fractionation that the oil has undergone, and the base from which it was derived. The Standard Oil Company of Indiana markets a motor oil under the name of "Isovis." This oil is diluted with naphtha or kerosene at the refinery so that it already has the composition of an oil that has been diluted by crankcase dilution. The amount of dilution with naphtha is based on the average dilution found in many makes of cars and hence in some engines part of the naphtha is lost, while in others dilution may occur. At present, the importance of the viscosity-temperature relation seems to overshadow all other physical properties at least from a theory standpoint. As an oil is heated, its viscosity decreases so that it may be unsuitable as a lubricant at the temperature at which the engine operates. Furthermore, even though the oil has a proper viscosity at the high temperature, it may be so viscous at starting temperatures that it fails to lubricate properly. The major usefulness of determining the color is to indicate the nature of the refining operation. Nevertheless, some companies have so improved the color that the costs of refining have been needlessly increased. The pour-point indicates the tendency of an oil to congeal at low temperatures and to fail to lubricate. Recent refinements in the art of dewaxing have led to the manufacture of zero and lower pour-point products. Low pour-point oils are uniquely valuable for certain purposes, such as for aeroplane oils, aircraft machine-gun oil, recoil oil, ice-machine oil, and motor oils in cold climates. Emulsibility and demulsibility are particularly important for oils that must be used in the presence of water or steam and for lubricating high-speed machines such as turbines. The carbon residue supposedly measures the tendency of an oil to deposit carbon in the internal combustion engine. However, the carbon residue does not indicate directly the amount of carbon formation. The amount of carbon that is produced is much less than proportional to the carbon residue.

The ranges of physical properties that may be found for oils of the different grades is indicated in Table 9. Thus it is apparent that the physical properties of the oils may overlap from one group to another because of the different bases of oil that may have been used in the manufacture and because of local marketing conditions.

Greases and waxes also constitute a large group of materials. Among the greases are crank-pin, rod, cup, axle and fibre greases. Petrolatum stock is also used in the manufacture of shoe polish, medicinal salves and vaseline. Paraffin wax is used as a sealing and insulating material, in candle manufacture, as a compounding material in the manufacture of waxes and salves, and in the manufacture of wax paper and matches.

The compounding of greases, etc., is often considered as an art, and few grease-makers use the same process of manufacture. Greases may be grouped into three classes.[3]

(1) Admixtures of mineral oil and solid lubricant. Some of the common solid lubricants are graphite, mica, talc, sulphur, and asbestos fibre. These greases are invaluable in the lubrication of ill-fitting machine parts functioning under heavy or intermittent loads. Examples of this type are tractor roller lubricants, lubricants for concrete mixers, ditch-digging equipment, and railroad car unloading devices.

(2) Blends of residuum, waxes, uncombined fats, rosin

TABLE 9

Properties of Lubricating Oil

NAME OF OIL:	Used for	A.P.I.	Viscosity at 100	Viscosity at 210	Flash (O.C.)	Pour-Point	Carbon Residue
1. Light Motor	Automobile	21-30	150-330	43-50	300-405	0-30	0.03-0.12
2. Medium Motor	Automobile	21-28	225-450	47-58	340-430	0-40	0.06-0.38
3. Heavy Motor	Automobile	20-27	300-650	52-77	360-450	0-40	0.1 -1.2
4. Extra Heavy Motor	Automobile	18-26	500-2100	70-125	370-470	0-45	0.2 -2.3
5. Diesel Engine	Diesels	22-25	.....	55-70	370-450	10-50	0.3 -0.8
6. Tractor	Tractors	22-25	.....	66-155	380-500	10-50	0.4 -1.8
7. Aero	Aeroplanes	23-26	.....	75-125	400-475	0-45	1.0 -2.5
8. Transmission	Automobiles	20-23	.....	90-175	440-515	40-60	2.5 -4.6
9. Cylinder	Steam engines	19-27	.....	90-330	415-630	35-70	1.5 -4.5
10. Engine	Heavy bearings	21-27	150-330	.....	350-550	0-35	.....
11. Crank Case	Steam engines, crank case, splash, etc.	22-27	190-330	.....	400-550	.....	.....
12. Turbine	Steam turbines, dynamos	26-32	90-285	.....	320-420	10-30	.....
13. Cold Test	Ice machine, recoil aircraft, machine gun, etc.	25-33	50-400	.....	90-450	—50 to —5	.....
14. Spindle, etc.	Light machines, weaving, spinning, automatics, etc.	26-35	90-150	.....	340-390	.....	.....
15. Black	Rough, slow-speed bearings, crushers, etc., cheap work	16-28	.....	95-160	375-450	15-40	.....
16. White	Machines in food plants, etc.	29-32	87-140	.....	290-380	.....	.....

B-M-W PRODUCTS for pumping wells
The KEY to LOWER LIFTING COSTS
CORRECTLY DESIGNED · · ECONOMICALLY PRODUCED
REASONABLY PRICED

Replacements on balls and seats and cups may be cut to the vanishing point • by using these • B-M-W products

B-M-W MONARCH

Made for severe service and harder than other non-corrosive Balls and Seats. No ball breakage. Resists erosive action of sand.

B-M-W CHROMARD

Stainless Steel — non-corrosive — stands up under cutting action of floating sand.

B-M-W EXTRARD BRONZE

Extremely hard bronze alloy—will perform where lodestone and corrosive elements are present.

B-M-W BRAMO

General purpose ball and seat—high grade tool steel—moderate in price.

B-M-W BI-METAL

Chromard Seat and Extrard Bronze Ball—for use where lodestone and floating sand are present.

TRIADS lead the field in performance — the finest composition cup you ever tried. B-M-W products available at all good supply stores.

BRADFORD MOTOR WORKS INC.
OIL WELL SUPPLIES
BRADFORD, PA. TULSA, OKLA.
EXPORT OFFICE – 30 CHURCH ST. – NEW YORK CITY

oils, and pitches. This group is particularly suited to the lubrication of rock bits, steel cables, water pumps, dredges and chains, cranes, and gears operating under water or under exposed weather conditions.

(3) Soap-thickened mineral oils. Common thickeners are sodium calcium, aluminum, and lead soaps. The soaps of these metals are prepared by saponification of a fatty glyceride of either animal or vegetable origin. This group is widely useful because a large variety of different consistency greases can be produced by selecting different metallic soaps, different fatty glycerides, and various mineral oils.

Paraffin wax is marketed according to the melting-point. The melting-point varies from 105 to 140 deg. fahrenheit. Crude wax is sold in two common grades having melting-points of 117 to 119 deg. fahr., and 124 to 126 deg. fahrenheit. Crude wax is used in the manufacture of matches, as a stuffing or loading material for leather goods, and in the textile industry for softening and lubricating yarn during winding. Refined wax must be free from odor, taste, and usually a white wax is required. A large quantity of refined wax is used in the water-proofing of food containers. Also it is used industrially as a lining for vats, tubs, containers, etc., in food-manufacturing plants. The highest grade of wax, having a melting-point of approximately 140 deg. fahr. is used for the manufacture of wax paper. Much of the high melting-point wax is imported and is prepared from East Indian petroleum.

QUESTIONS

1. List what you consider as the three most important tests for fuel oils.
2. What are the two general groups of fuel oils?
3. In what two ways does the viscosity of a fuel oil affect its suitability as a fuel?
4. What are the two most important properties of asphalts?
5. What is now the most common method of grading motor oils?
6. What is the significance of the flash-point of a motor oil?
7. Why is it possible to have a range of gravity of 21 to 28 in a medium motor oil?
8. What are the particular uses for "cold-test" oils?

REFERENCES

[1]U. S. Bureau of Standards, CS 12-33 (1933).

[2]Oil; Lubricating, Class D VV-O-496, U. S. Government publication. Obtainable from Superintendent of Documents, Washington, D. C.

[3]Simpson & Welch, "Manufacture of Grease," *Refiner and Natural Gasoline Manufacturer*, p. 77, March, 1931.

[4]Livingston & Gruse, "Carbon Deposits from Lubricating Oil," Ind. Eng., Ch. 21:904, 1929.

[5]Foster, "Work Factor Used in Buying Lubricants . . . " *The National Petroleum News*, p. 6, February 12, 1930.

[6]Anon., "Free-Wheeling Lubricants," *Journal S.A.E.*, 30:49, 1932.

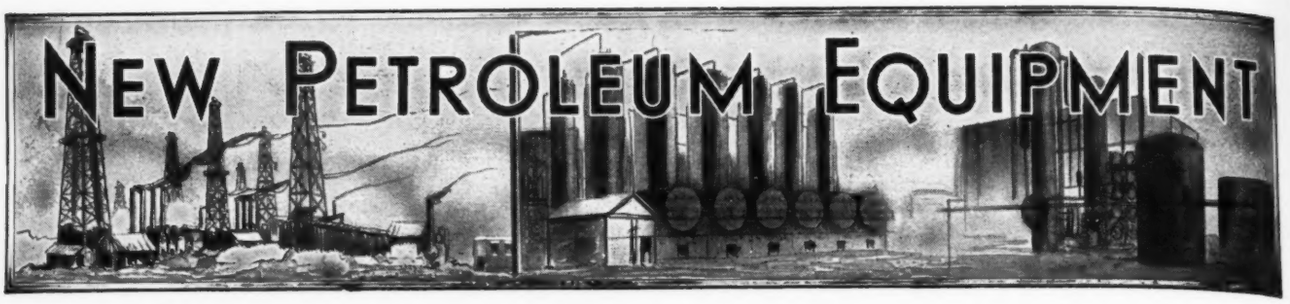
[7]Staley, "Road Oil Specifications and Refining Methods," *The Petroleum Engineer*, p. 35, June, 1932.

[8]Leslie and Ennis, " . . . Asphalt and Cut-Backs in Repair and Maintenance of Roads," *Oil and Gas Journal*, p. 13, October 20, 1932.

Mine Safety Appliances Company Opens New Warehouse Branch

Mine Safety Appliances Company, Pittsburgh, Pennsylvania, has established a warehouse branch at Houston, Texas, under the direction of George J. Gruber, its original representative in the Texas-Louisiana territory, and John B. Baird. The Houston warehouse carries an extensive stock of MSA equipment, including masks, respirators, first aid materials, goggles, protective hats, safety shoes, inhalators, safety belts, etc. The new branch address is Mine Safety Appliances Company, 2018 Capitol Street, Houston, Texas.

OIL INDUSTRY PUMPS
Made by
OIL INDUSTRY MEN
for
OIL INDUSTRY
Service
They're made in the heart of the oil country to stand the gaff of oil industry use. Back of them is a firmly established, responsible company organized to render the type of service the oil industry requires. Isn't it logical, under those conditions, that an ever-increasing group of oil men should insist upon them?
Wherever oil is found the word GASO is accepted as an unfailing symbol of pump service, pump life and pump economy.
Gaso Pump & Burner Mfg. Company
902 E. First St., Tulsa, Oklahoma
Export Office: 149 Broadway, N. Y.
GASO FULL-AUTOMATIC FIELD PUMPING UNIT UTILIZING GAS OR GASOLINE DRIVE
GASO
GASO PUMPS
for every oil industry need



Important Improvements In New M.I.W. Derrick

THE MUSKOGEE IRON WORKS, which for 11 years has been manufacturing a well-known make of derrick, has entered the field with a new, improved derrick, made in its own plant and sold under its own name.

A number of interesting features are incorporated in the M.I.W. derrick. Erection is facilitated by having less parts and, therefore, fewer bolts. Among other improvements are two-bolt connections throughout, so that there is always a hole for a pin to bring the member in contact while a bolt is being inserted. Any M.I.W. derrick can easily be erected in a day's time, the manufacturers state.

Other construction features include: milled joints, silicon steel legs, gin poles specially locked in place, and a specially designed ladder connection which is not dependent on the bolt staying in place, thereby making the ladder absolutely safe at all times.

The Muskogee Iron Works has one of the largest derrick plants in the Southwest and carries in stock approximately 3000 tons of derrick material. Derricks in standard sizes are shipped the same day orders are received. Special derricks can be made ready for shipment on short notice.

The Muskogee Iron Works is a three-quarter-million-dollar institution, 25 years old. Manufacturing facilities include a structural shop, galvanizing plant, a machine shop completely equipped for producing any articles, and foundry. The company maintains a large and experienced engineering department.

This company is also well known in the oil industry as builders of skid winches, pipe-laying booms, hoists, power take-offs and a complete line of structural steel buildings for refineries, gasoline plants, etc. The Muskogee Iron Works is internationally known, having shipped and erected its materials over the entire world. Some of the equipment used in laying the pipe line across the country of the Iraq was furnished by the Muskogee Iron Works. The company also has shipped buildings as far away as the island of Guam.

Main offices of the Muskogee Iron Works are at the plant in Muskogee, Oklahoma. Branch sales offices are at 1115 First National Bank Building, Dallas, Texas.

Oil Centrifuge Operates from Car Battery

GREENE BROTHERS, INC., Dallas and Wichita Falls, Texas, have placed on the market a 6-volt oil centrifuge that can be permanently installed in any automobile, operating from the car battery. The equipment complete weighs only 15 pounds. The centrifuge operates at a speed of 300 to 2200 r.p.m. loaded and the motor has an approximate hp. of 1/10. The current drain is approximately 12 amperes at six volts. Roller bearings on the top and bottom act as radial and thrust bearings. Other features are a high starting torque and a knife-edge balancing of the head.

Numerous difficulties were encountered in designing and constructing the centrifuge, the manufacturers state. Cool operation of the unit with the large wires required to carry a load of 12 amperes presented a problem that was solved by increasing the number of turns in the field coils. Additional difficulties that were successfully overcome included the designing of a brush and commutator capable of carrying 12 amperes of current for long periods of time; the balancing of the armature in the electrical center of the field with the thrust bearing able to stand the necessary amount of play for the floating armature; knife-edge balancing of the head; designing a rheostat with a taper wound to carry the amount of current necessary to handle the speed of the motor without getting hot and with positive contacts that produced no wear on the wires. Armature and commutator had to be made in many more segments than a regular motor of this size in order to obtain high starting torque.

The centrifuge readily meets the A.S.T.M. Standards required for a 15-cc. centrifuge, the manufacturers announce.

First Shown at the World's Fair in June

Now Ready for the Road:

A new and greater line of

INTERNATIONAL TRUCKS

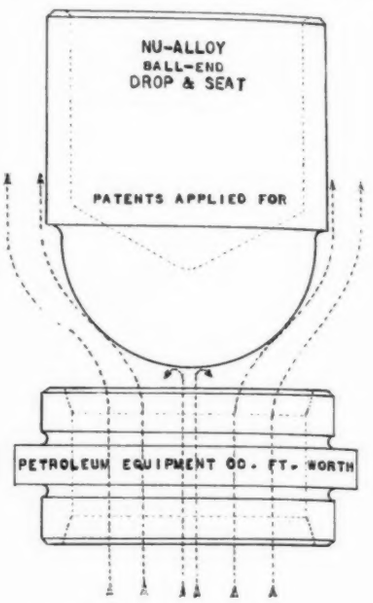
Latest and finest of trucks... A new high in style and distinction... New values in utility and performance... *A complete new line of Internationals!* The powerful 4- to 5-ton unit below is one of a beautifully streamlined series of trucks that are *all-truck*, embodying new engineering features and new mechanical excellence throughout. Take Harvester's word for it—the quality apparent on the surface is more than matched by the quality underneath. It is the *EXTRA quality* that International Truck owners have banked on *for more than thirty years*. See these new Internationals. All models, from ½-ton up, now on display at International branches and dealers. For details, write International Harvester Company of America, Inc., 606 S. Michigan Ave., Chicago, Ill.

Petroleum Equipment Company's Streamline Drop and Seat

THE PETROLEUM EQUIPMENT COMPANY, Fort Worth, Texas, manufacturers of pumping equipment, announce that, although they will continue the manufacture of their Ball End drop and seat, they are introducing a new streamline drop and seat. This drop and seat has been tested under the most severe pumping conditions in the Mid-Continent. The outstanding feature of Nu Alloy Ball End drops, as well as the new Streamline drop and seat, is that no special crown equipment is required — they will operate in any standard or A.P.I. valve crown.

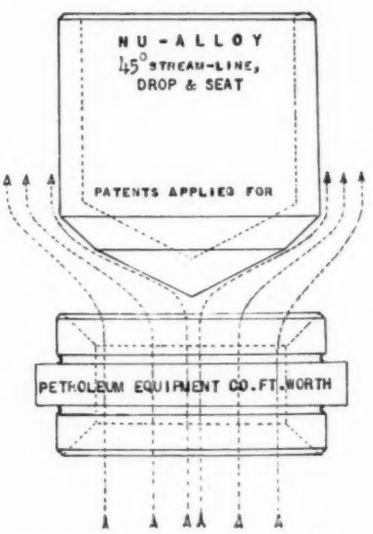
The Nu Alloy Streamline drop and seat incorporates a combination of angles that eliminate turbulence and velocity that are present when flat surfaces oppose the flow of fluid. The Streamline drop is especially resistant to erosion as the taper on the end of the drop deflects the fluid clear of the sealing seat, as shown in the illustration.

The manufacture of Nu Alloy Ball End and Streamline drops and seats is controlled in the company's plant with laboratory precision from the machining from the bar stock to the



heat-treating in electric furnaces operated by automatic pyrometer control, then precision ground to size, after which each drop is hand-lapped into its individual seat, insuring a perfect seal and resulting satisfactory service.

Nu Alloy drops and seats are available in a number of different grades of stainless steels, with various corrosive- and erosive-resisting properties. They also are available in tool steels,



monel and bronze. All Nu Alloy seats have normalized rim sections that eliminate breakage, the manufacturers state. Descriptive literature and prices are available from the Fort Worth office, or representatives of the Petroleum Equipment Company.

COLOX PROVES GREAT HELP IN CONTROLLING HEAVING SHALE

OPERATORS have found that Colox is the ideal mud for drilling heaving shale. It makes mud of low viscosity and the desired weight. Builds a strong, thin wall; preventing free water from coming into contact with the formations. Colox stands up under chemical treatment.

Our Engineering Department is available to operators in all Gulf Coast fields of Texas and Louisiana. Also in West Texas and New Mexico. Let them help you with your mud problems.

manufactured under exclusive license by

Geo. S. Mepham Corp.,
2001 Lynch Ave., East Saint Louis, Ill. for Mid-Continent and Gulf Coast areas and

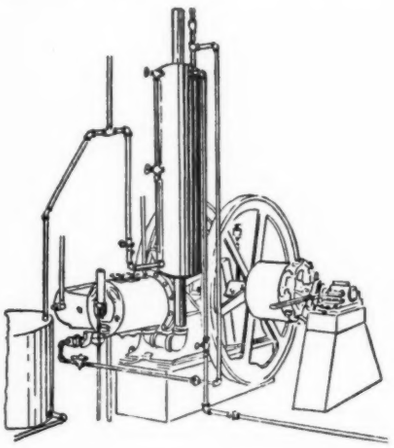
C. K. Williams & Co.,
of California, Ltd., Shellmound Park, Emeryville for Pacific Coast area
Under U. S. Patents Nos. 1,575,944-5

colox
COLLOIDAL IRON OXIDE

Distributed by The Republic Supply Co., in the Mid-Continent and Gulf Coast areas

Gas Generator of American Iron & Machine Works

AMERICAN IRON AND MACHINE WORKS COMPANY, Oklahoma City, Oklahoma, has developed a new gas generator which, the manufacturers state, will enable operators to minimize fuel costs. The American Generator is designed to generate gas from



crude oil by pumping oil direct from the well into a tank and then allowing it to by-pass into the well. This method allows little, if any, loss of gravity.

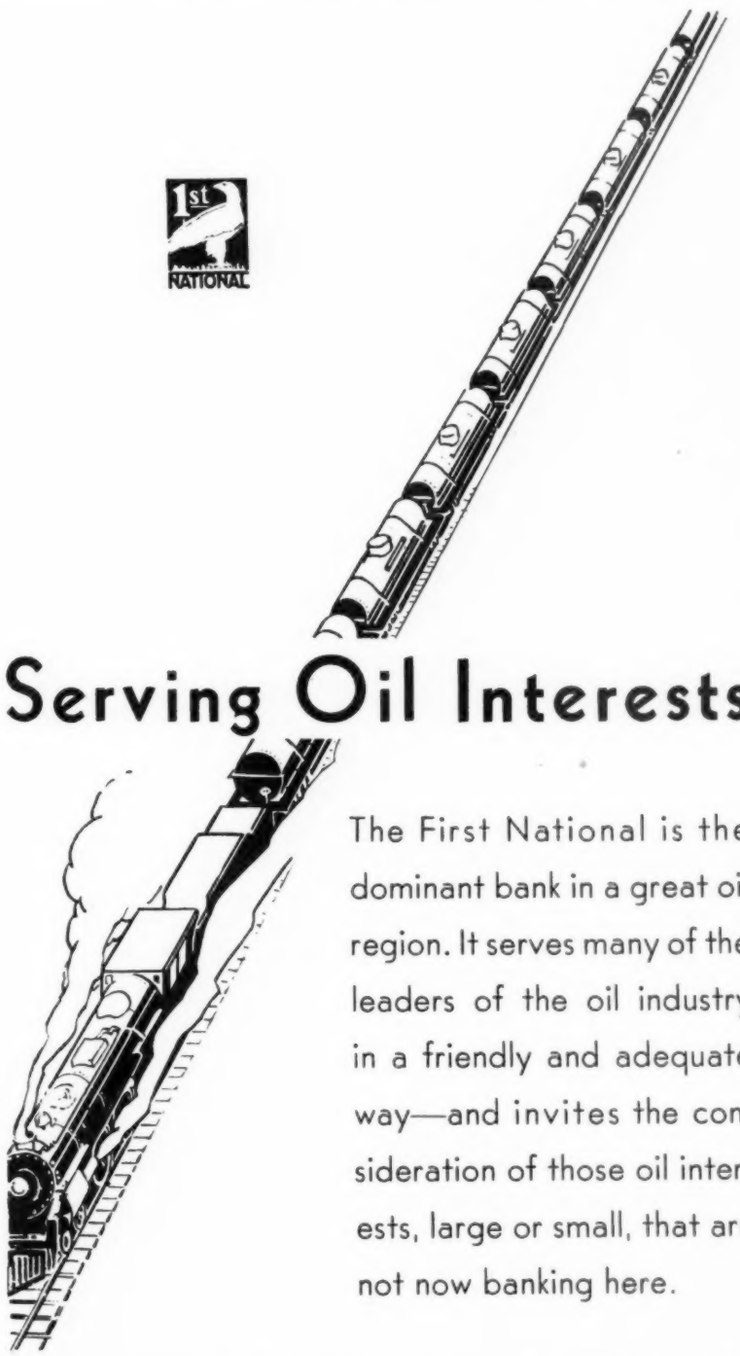
This generator was developed especially for use in oil fields where gas pressure has diminished to the extent that oil, gasoline or electricity have to be used. Fuel costs are practically negligible when this method is used, it is stated. This is an entirely new method that has been worked out by American Iron and Machine Works Company, and patents have been applied for.

The generator is simply and inexpensively installed, the manufacturers state. It is set above the engine, thereby occupying no additional space. Complete information may be had from American Iron and Machine Works Company, Oklahoma City, Oklahoma.

Oxweld Cutting Blowpipe

THE LINDE AIR PRODUCTS COMPANY, 30 East 42nd Street, New York, N. Y., has announced a new oxy-acetylene cutting blowpipe, known as the Oxweld Type C-24, designed essentially to serve as a general-duty cutting blowpipe, but capable of doing heavier work if necessary. It will operate with less oxygen pressure than any preceding Oxweld cutting blowpipe. Some of the outstanding features of this new blowpipe are: an entirely new

design of cutting oxygen valve, the valve being placed in an easily accessible position; a long external cutting valve lever that makes the valve easy to operate with the hand in normal gripping position; nozzles with seat protectors; closer spacing of the heating orifices about the cutting oxygen opening; new nozzle sizes; interchangeable large-capacity ball-type inlet-needle-valves; and interchangeable low-pressure injector or medium-pressure mixer.



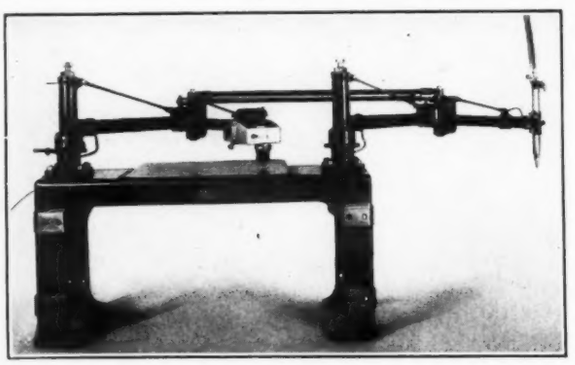
Serving Oil Interests

The First National is the dominant bank in a great oil region. It serves many of the leaders of the oil industry in a friendly and adequate way—and invites the consideration of those oil interests, large or small, that are not now banking here.

First National Bank
in Dallas

Airco Introduces New Pantograph-type Gas Cutting Machines

THE AIR REDUCTION SALES COMPANY, 60 East 42nd Street, New York, has added to its line of Pantograph-type gas cutting machines two new units, designated as the Airco-DB No. 7 Oxygraph and the Airco-DB No. 1 Travograph. The No. 7 Oxygraph employs a pantograph construction, in which the fourth side of the parallelogram is removed to the rear. This arrangement allows the working ends of the arms to swing between the vertical posts that support the pantograph assembly, as well as in back of them.



The No. 7 Oxygraph has no tracer bar, the tracer being attached to the end of one pantograph arm and the cutting torch to the end of the other. It is designed for single-torch operation only. In this machine the tracing table for holding the full-scale drawing is part of the machine and is located on top of the bed between the vertical posts.

Either a manually controlled or a magnetic tracer can be used with the No. 7 Oxygraph, each, however, requiring its respective adapter. When using the magnetic tracer cams are mounted overhead, attached to the substantial shank with nut located on top of each vertical post.

On No. 1 Travograph, the pantograph assembly is mounted on a carrier that travels on rails. It is fitted with a long tracer bar, attached to the outer ends of the pantograph arms. The tracer mechanism and cutting torch holders are mounted on this bar and may be moved to any position along the bar and secured in place by set screws. As many as six cutting torches may be mounted on the bar for multiple cutting.

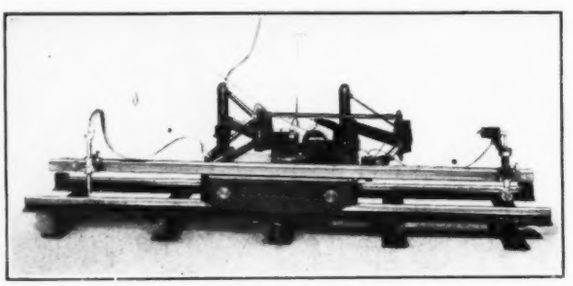
The No. 1 Travograph also can be operated with either manually controlled or magnetic tracer. The cams used with the magnetic tracer are mounted on the tracing table of this machine.

In operating the No. 1 Travograph, the pantograph assembly is swung by hand, the tracer being lowered until its full weight rests on the table, the torch adjusted to the proper height above the work and the driving motor started. The operator then guides the tracer along the lines of the drawing until the cut is completed.

Automatic control of the carrier driving motor by the movement of the pantograph arms is a feature of the No. 1 Travograph. As these arms reach certain limiting positions in their swing in either direction, they operate switches which actuate the magnetic reversing starter of the carrier motor.

The pantograph assembly on both machines have arms of rugged proportions, adequately braced for maximum strength and rigidity under load. Hinge fittings likewise are amply proportioned. All bearing surfaces are of large area and accurately machined. The bearings that mount the assembly at the vertical posts, and all hinged joints, are equipped with large diameter ball bearings, designed for both thrust and radial loads.

The No. 1 Travograph carrier also



is precision built and has large wheels with ball bearing axles for smooth, easy running. The electrical circuit provides for giving the carrier driving motor a slow starting speed and smooth pick-up. At each end of the carrier base a limit switch opens the carrier motor circuit and brings the carrier to a gentle stop. The carrier drive can be disengaged by a clutch, which permits quick positioning of the carrier along the track. The carrier is adequately counter-weighted to offset the leverage of the pantograph with arms fully extended, and safety hooks preclude any possibility of accidental tipping.

The rails on which the carrier runs are specially rolled tie sections, 16 ft. long, with tops or threads accurately machined. They are bolted to five large H-beam sections which serve as ties and supports for the machine.

Both the manually controlled and magnetic tracers for No. 7 Oxygraph and No. 1 Travograph are equipped with variable-speed motors, which permit the cutting speed to be regulated by merely turning a speed governor screw on the motor.

The cutting area or range of the No. 7 Oxygraph is a 30-in. square or a 36-in. diameter circle, while that of the No. 1 Travograph is a rectangle 4½ ft. in width and 11 ft. in length with one 16-ft. section, or any length desired with additional rail sections.

Mason-Neilan Recording Thermometer

A NEW recording thermometer has been announced by the Mason-Neilan Regulator Company, Boston, Massachusetts, manufacturers of automatic regulating and control equip-

ment. This recorder is furnished in an attractive square Duralumin case with chromium-plated hinges and hasp. It is equipped with floating coil clamp that is said to increase its accuracy by eliminating friction and lost motion.

These instruments may be equipped with the distinctive new Over-Heat Protector, a safety feature that definitely protects the thermal element if temperatures exceed the instrument range. It is claimed that with this new protector excess temperatures of 500 deg. fahr. over the maximum chart range will cause no damage.

Recorders with multiple pens for recording several different temperatures can be furnished if desired. All parts are standardized and are interchangeable with other Mason-Neilan temperature control instruments. An illustrated folder describing these recording thermometers is just off the press and will be sent upon request by Mason-Neilan Regulator Company, 1190 Adams Street, Boston, Mass.

Making *Tomorrow's* History *Today!*

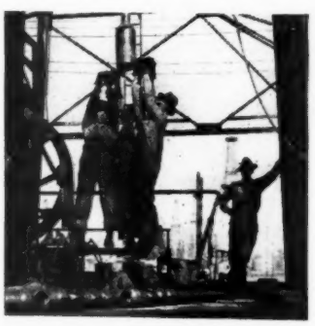
AN INSTANT success only 12 months ago, Gun Perforator Service has brought satisfaction to more than 124 different companies in hundreds of wells, under conditions previously considered impossible.

Completely self-contained truck units are ready for service day or night, rain or shine.

PERFORATING 7 days each week — often several wells during 24 hours — efficient service trucks have been making tomorrow's history. Larger and faster units are today proving our slogan: "If the Oil is There, We Get It" — at a cost so low that it is often repaid by one day's extra production.

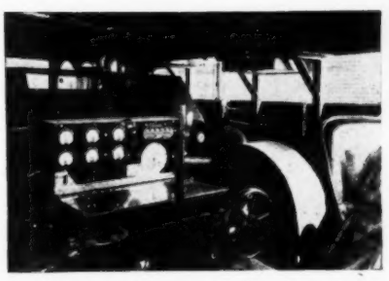
MID-CONTINENT AND FOREIGN

Gun Perforator Service is now available on the Gulf Coast — see below. Arrangements are being perfected to cover the entire Mid-Continent and major foreign fields. We invite your detailed inquiries.



Lowering Lane-Wells Gun Perforator into the well.

Rear view of truck showing Guns in upper compartments and individual loads in trays below. Note complete, compact equipment.

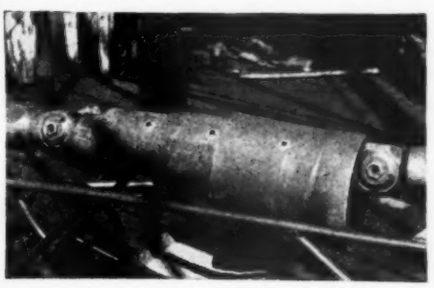


The "shooter's seat" showing depth measurement gauges, operating controls and instruments to prove actual detonation of charge in the well.

The Lane-Wells Magnet Fishing Service — another of "Tomorrow's Tools — Today!"

Gun Perforation consists of electrical detonation of powder to propel a steel bullet through one or more strings of casing, with cement filling both the annular spaces between the strings and the space back of the casing. Clean perforations are spaced as desired, at any specified depth, without distorting the casing. Gun Perforator Service comes to your well on a completely self - contained truck unit. You supply nothing except ordinary pulling equipment usually on every well.

Ready for a test shot through 6⅝" 26-lb., 8⅝" 36-lb. and 10¾" 45-lb. casing.



Result of test shot described above. Similar perforations are obtained with cement between casing.

CALIFORNIA SERVICE

Additional and larger equipment is today available to give you prompt, dependable service in all fields. Our telephone number is JEfferson 5289.

GUN PERFORATOR SERVICE

On the Pacific Coast
THE LANE - WELLS CO.
4439 Santa Fe Avenue
Los Angeles, California

Fully protected by Patent No. 1,582,184, and other patents pending.

On the Gulf Coast
TEXAS IRON WORKS SALES CORP.
1401 Maury Street
Houston, Texas

Wax Deposits in Pipe Lines

Turbulent Flow May Lessen Deposition

By M. T. BUFORD

TO approach the problem of the formation of wax crystals that deposit in pipe lines, it is quite essential first to review a few of the factors influencing wax crystallization. Naturally, to overcome wax deposits in lines, the pumping conditions must be made inconsistent with those conditions favorable to wax crystallization.

If crude oil is cooled without agitation, paraffin wax is crystallized in small needle-like crystals. These crystals grow until they attach themselves into a network not unlike the fibers of a cloth. It is not possible for oil to move through this network; consequently this wax film serves as a new wall next to the pipe. Similar structures build up until the deposit is thick enough to make a noticeable difference in the efficiency of the line. This factor accounts for the major part of the deposit where stream-line flow exists.

Pressure carried on the line, as well as the presence of gas, air, or water dissolved in the oil, has little or no effect on the wax deposits and may be disregarded.

The next factor to consider seriously is evaporation. If the pipe is warmer than the oil, evaporation occurs and the wax solubility decreases, the wax precipitates out of the solution to be deposited when and where the proper condition exists. Lines exposed to the sun or any other source of heat will be greatly influenced by this factor.

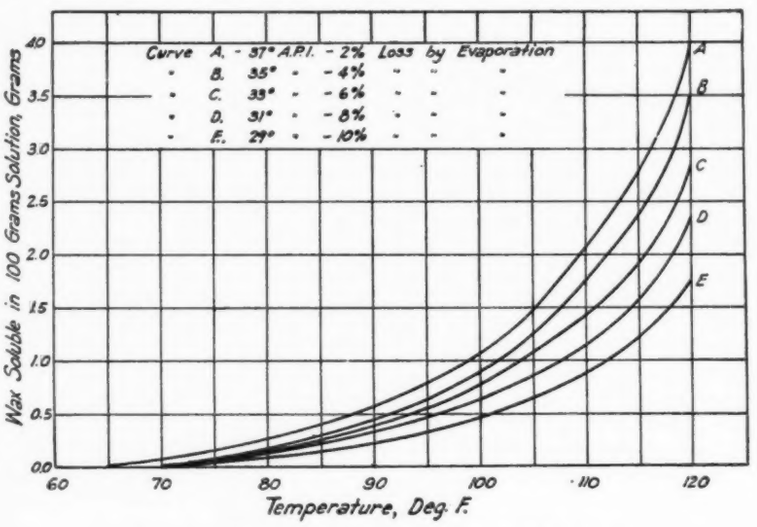


Fig. I. Effects of evaporation on solubility of wax in crude oil

Fig. I will explain the effect of evaporation on the solubility of wax in crude oils.

Sand and silt carried in the crude oil has no effect on the solubility of the wax, but will act as nuclei for the wax crystals, causing larger and heavier crystals. This type of formation would seek the lower levels in the line and will cause excessive deposits. Large balls of wax are occasionally found in the lines where sand and silt are carried in the oil.

If the pipe is cooler than the congealing point of the oil, wax is crystallized and precipitated out. This factor is usually of little consequence except in crude oils of extremely high pour test.

The speed of the oil in the pipe seems to be the best solution to the problem in that at high velocities turbulent flow occurs. In turbulent flow, several of the wax-forming factors are eliminated and the others greatly retarded. Other things being equal, stream-line flow exists at lower velocities.

Turbulent flow, unlike stream-line flow, maintains a velocity next to pipe walls, thus agitating the oil and preventing the formation of network deposits. Continual wash against the wall of the pipe will tend to cool the pipe, preventing evaporation and line losses.

Turbulent flow will not prevent the "balling up" of wax crystals, as it tends to hold the sand and silt in suspension. However, sufficient settling time of the crude in tanks will remove this undesirable feature.

A simple formula in hydraulics has been proved experimentally to indicate stream-line flow and turbulent flow.

To calculate the quantity of fluid flowing in a pipe, the mean velocity of the fluid multiplied by cross-sectional area of the pipe will give the result. The mean velocity of fluid is equal to a constant, K, times the maximum velocity. Then to calculate the quantity of fluid flowing, the value of K must be known.

Experiments have shown that all fluids (both liquids and gases) behave in precisely the same manner, and by knowing the viscosity at the temperature the fluid is flowing, we can at once deduce the value of K for any given speed.

This value of K is known as the modulus of viscosity and may be written in the following expression:

$$M = \frac{d \times P \times V}{u}$$

where: d = inside dia. of pipe in ft.
P = density of fluid in lb./ft.^{3}
V = mean velocity in ft./sec.
u = viscosity in English units
M = a function of K $\frac{\text{lb.}}{\text{ft.} \times \text{sec.}}$

If the value of M is less than 2500, stream-line flow exists; if greater than 2500, turbulent flow exists. From this the value of K ranges from 0 to 0.69 for stream-line flow and from 0.69 to 1 for turbulent flow.

The mean velocity may be calculated from the volume flowing per second by means of a pitot tube, orifice meter, venturi tube formulas, or tank gauges, and using the simple formula:

$$V = \frac{0.134 \times G.P.S.}{A}$$

where V = mean velocity

G.P.S. = gal./sec.

A = cross-sectional area of pipe in ft.

REFERENCES:

Martin's Treatise on Chemical Engineering.

Rustle & Blade, U. S. Bureau of Mines Bulletin No. 348.

Padgett, F. W., "The Crystallization of Petroleum Wax."

Charles N. Hough Manufacturing Co. Opens Tulsa Warehouse

The Charles N. Hough Manufacturing Company, Franklin, Pa., opened a warehouse in Tulsa, Oklahoma, August 1, located at the northwest corner of Cameron Street and North Boston Avenue. A floor space of 7000 sq. ft. has been provided and a complete line of oil well pumping equipment installed. Heretofore the company has never carried a stock in western territory and from the Tulsa warehouse distribution will be made into the Mid-Continent and Gulf districts.

L. L. Reib, factory representative, has been transferred from Franklin to Tulsa and will be in charge of the warehouse. The sales personnel in the territory remains the same: C. O. Shumaker, 1143 South Xanthus Street, Tulsa; C. S. Vogel, 2001 Hemphill Street, Fort Worth, Texas; and Frank L. Scott, 502 Selman Street, Tyler, Texas.

Universal Oil Products Co. Claims Patent Infringements

Infringement of cracking patents is charged in lawsuits filed by Universal Oil Products Company, Chicago, against four Mid-Continent refiners. The defendant companies are the Eldorado Refining Company, Eldorado, Kan.; Globe Oil and Refining Company, McPherson, Kan., and the Kanotex Refining Company, Arkansas City, Kan.

The defendants are charged with infringing the Dubbs clean circulation patent and the Egloff two-coil patent. All claims are alleged to be infringed except Claim Six in the Dubbs patent. These are the two patents which Federal Judge John P. Nields found to be valid and infringed in the suit of Universal against the Root Refining Company.

The Eldorado and the Globe companies are using Winkler-Koch cracking units, the Dickey company a cracking unit of its own design, and the Kanotex a so-called Winkler-Koch unit licensed under the Donnelly patents.

The suits were filed in the Federal District Court at Wichita, Kansas.

P. J. Dasey and T. E. Brandon with Mid-Continent Supply

P. J. Dasey, well-known engineer, has recently become associated with the Mid-Continent Supply Company, Fort Worth, Texas, in the capacity of sales engineer, specializing in the sale of Cummins Diesel engines for which the Mid-Continent Supply Company is exclusive distributor in the Mid-Continent territory.

T. E. Brandon, well known in the petroleum industry, recently joined the sales department of the Mid-Continent Supply Company, and expects to spend most of his time in the West Texas territory.

WE "BRING 'EM BACK ALIVE"

SERVICE OFFICES

Breckenridge, Texas
Phone 206

Big Spring, Texas
Phone 285

Wichita Falls, Texas
Phone 2-4307

Seminole, Oklahoma
Phone 844

Wichita, Kansas
Phone 2-2478

Acid treatment not only hastens the recovery of oil, thereby enabling you to reduce your lifting cost materially, but it will also reach back into new reservoirs and recover oil which never could be recovered in any other way.

Our practical, common-sense method of treatment has meant hundreds of thousands of dollars to the oil operators in the lime producing areas of the Mid-Continent fields.

We are the pioneer acid treating company in the Southwest and every man on our staff is a highly competent and thoroughly experienced oil well man.

Consult with us about your particular problem. Our laboratory service is free, and we shall be glad to give you the benefit of the experience we have gained in treating more wells than any other company in the Southwest.

We are the largest users of hydrochloric acid in the United States.

THE CHEMICAL PROCESS COMPANY INC.

Main Office: Highers Building, Breckenridge, Texas

C. K. WEST, *President* — H. V. MELVILLE, *Vice-President* — P. W. PITZER, *Secy-Treas.*

New Precision in

CHEMICAL TREATMENT OF CRUDE OILS

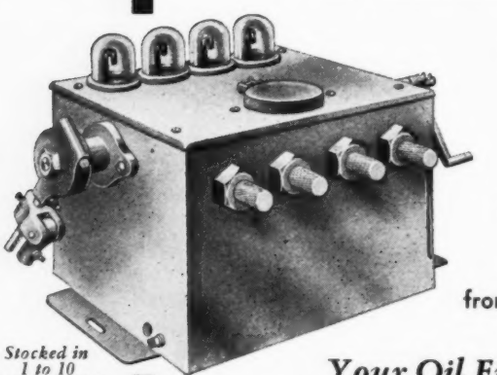
EACH pumping unit of the new "Standard" high-pressure lubricator when used as a chemical injector not only assures continuous unvarying treatment of oil en route from well to pipe line delivery point but each unit is separately adjustable. Parts of all units are interchangeable; and adjustment or replacement is quickly and easily made without using tools and without interrupting action of other pumping units.

Standardize Your Treatment of Crude Oils with

STANDARD
FORCE and SIGHT FEED
LUBRICATORS

This COUPON BRINGS *Complete Facts* FREE!

Equipped with roller-bearing clutch instead of Ratchet Wheel, Pawl and Pawl Springs—and with Bronze Oilless Bearings instead of Stuffing Boxes—and with die-cast Pumping Unit; stainless steel plungers; hardened, precision-fit stainless steel valves (no balls)—"Standard" Lubricators give continuous and accurate chemical injection at lowest cost over a virtually endless service life.



½ Pint to 2 Gals. per 24-Hour Day from Each Feed

Stocked in 1 to 10 Feed Models

U. S. Patent No. 1,949,272

Your Oil Field Supply House can Advise Best Application

AMERICAN LUBRICATOR COMPANY,
First National Bank Bldg., Dallas, Texas.

Gentlemen: Send complete facts about Standard Force and Sight Feed Lubricators used to chemically treat crude oils.

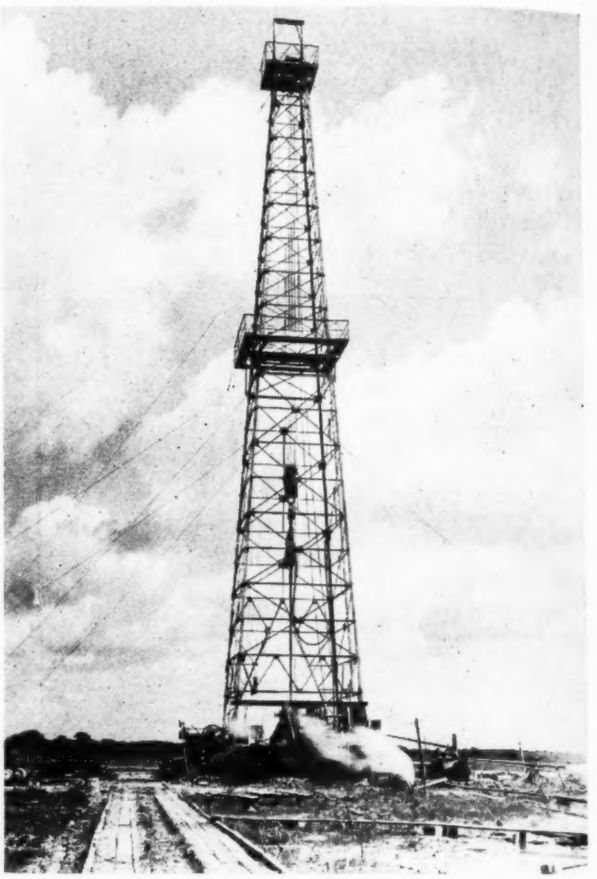
Name.....

Address.....

.....

The First 136-ft. Derrick in the Gulf Coast

The Pure Oil Company recently erected at its Stewart No. 2 well at Louise, Texas, the first 136-ft. derrick ever used in the Gulf Coast. Until now the usual derrick chosen for deep-well operations in that district has been the standard 122-ft. A.P.I. derrick. This innovation may have a bearing



on the future selection of derrick equipment for deep-well operations in the Gulf Coast and neighboring districts.

With the advent of the new 30-ft. drill pipe length, and with the increased size of traveling blocks and elevators, the need for more head-room in the derrick is rapidly becoming apparent. The additional 14 ft. above the finger board provided in the 136-ft. derrick permits greater hoisting speed with increased safety.

The 136-ft. x 26-ft. derrick has more floor area and more area at the finger board than the 122-ft. x 24-ft. derrick. In deep-well operations this additional space for drill pipe set-backs is particularly desirable. Moreover, the encroachment of the increasingly larger floor equipment is gradually making the floor space on the standard 24-ft. base inadequate for convenient and efficient operations. For this reason, the larger base of the 136-ft. derrick should prove most advantageous.

The Stewart No. 2 well was started about February 20, 1934. It is now drilling at 7600 feet. At 6500 ft. 9⅝-in. grade "D" 44.3-lb. seamless casing was set. To a depth of 4514 ft. 6-in. 22-lb. drill pipe in 30-ft. joints was used, below which point 4-in. 16-lb. drill pipe was used.

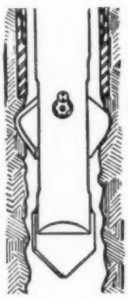
The drilling contractors, Smith & McDannald, are using the following equipment at this well: Ideco A.P.I. 136-ft. derrick, capacity 537,000 pounds; Ideco Super-Duty Jackshaft drawworks; Ideco Type "LR" 5-sheave crown block; Ideco 72-in. 5-sheave streamline traveling block; Ideco 27½-in. oilbath rotary; Union Tool 12x12 engine; Gray 6-in. swivel; Union Tool 8-in. square hook; and 1⅛-in. wire line.

HERE'S the SAFE, SURE WAY to GET BIGGER, BETTER WELLS

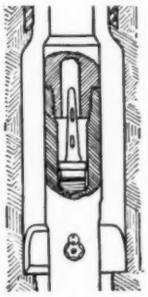
You want bigger wells, and will agree that by cleaning and enlarging the area of the producing sand greater production usually can be secured in any well. But, until you have used a Baker Hydraulic Expansion Rotary Wall Scraper you cannot realize how simple and how safe it is to secure bigger and better wells by scraping away all plastered rotary mud and weighted materials which are sealing off your oil. You can cut away the oil sand to a diameter almost twice the size of the last string of casing, and set liner easily.

These drawings will help you to visualize the safety and the great capacity for expansion of the Baker Rotary Wall Scraper, and how it will help you secure "bigger" wells.

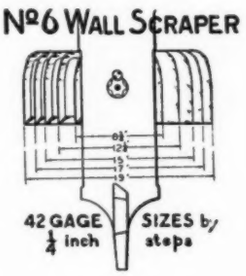
Running - in the hole with blades closed in body.



Blades cutting into formation as pumps and rotation start.



Blades fully expanded in cutting position.

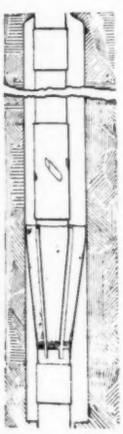


Minimum and maximum gauge of hole possible to cut with one size Wall Scraper.

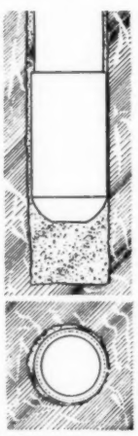
You also want "better" wells, and here again the Baker Wall Scraper will safely and surely enlarge the hole around the shoe, to insure a better job of cementing the casing.

The Baker Wall Scraper also will help you to drill straight, vertical hole in which you can set larger size casing and liners.

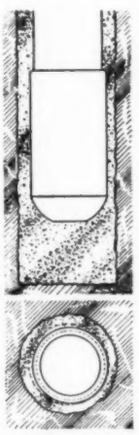
Here again pictures will best reveal its advantages . . .



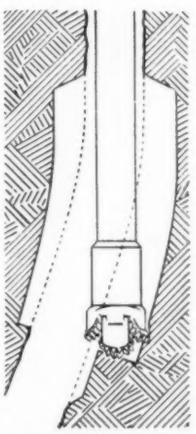
"Bottle - necked" or a perfect C.P. cementing job.



Without "wall scraping" — no "bottle-neck" — a poor cement job.



A perfect scraped, "bottle - necked" cavity, ready for cementing.



"Wall scraping" a wide shoulder for straightening a crooked hole.

The complete bulletin, sent promptly upon request, will bring details, specifications and prices.

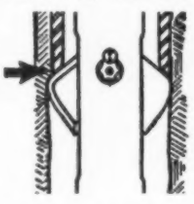
A FEW EXAMPLES OF WALL SCRAPER PERFORMANCE

Increasing Gauge of Hole. After neighboring well caught fire, State Authorities ordered this operator to set three strings of casing in order to set 7" pipe on the oil sand. It was necessary, therefore, to set and properly cement 10¾" casing through a 250-foot string of 13" O. D. casing already cemented in the hole. This was made possible by under-reaming the 12¼" hole (already drilled) to 15" with a No. 6 Baker Wall Scraper. The operator voluntarily spread the news that the Baker Wall Scraper had saved him about $700.00.

Cleaning Wells After Pulling Liner. A No. 4 Baker Wall Scraper equipped with 10½" blades was used to scrape and clean the oil sand after pulling the liner in a hole originally drilled to 8⅝". Only five hours were required for completion of this job to the entire satisfaction of the owner.

Setting Liner in Enlarged Hole. This operator desired to set 6⅝" liner through an 8⅝" water string, and used a No. 4 Baker Wall Scraper equipped with 9¼" blades. Only two sets of blades were required to ream 1,000 feet of 7⅞" hole (drilled in sandy, blue shale) to a gauge of 9¼". Total time consumed was less than 16 hours.

THE BLADES ALWAYS CLOSE When the string is raised, the blades of the Baker Wall Scraper close downward into the body. But even if a piece of rock or metal should wedge in the blade slot, when the top of blade contacts the casing shoe, like this . . the strong steel blade will shear through the obstruction and close safely inside the body. In shop tests, 1-inch steel bolts have been sheared through in this manner by applying pressure equivalent to six points on a weight indicator.



NRA WE DO OUR PART

BAKER OIL TOOLS, INC.

SEE OUR DESCRIPTIONS IN THE COMPOSITE CATALOG

P. O. BOX 609, HUNTINGTON PARK, CALIFORNIA

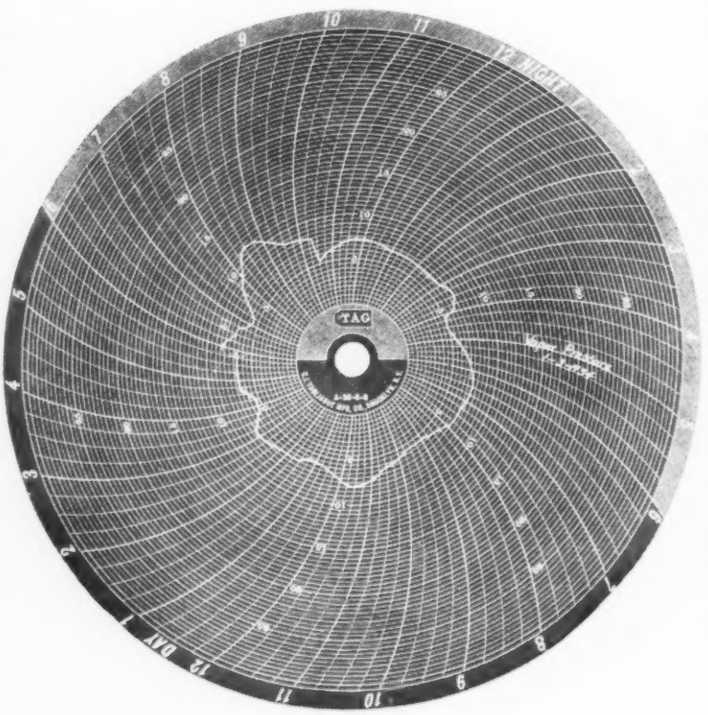
COALINGA • TAFT • HOUSTON • OKLAHOMA CITY • TULSA • NEW YORK

The Control of Vapor Pressure

By
F. L. KALLAM*

IN the operation of a natural gasoline stabilizer, information that permits visualizing the existing conditions under which the operation is carried out is ordinarily obtained from pressure and temperature instruments. This information is then analyzed and conclusions drawn regarding the results that will be obtained under the observed conditions. If this analysis should indicate, in the light of past experience, that an unfavorable result will be obtained, certain conditions of operation will be altered until the desired results are assured.

Experience has shown in the case of the conventional stabilizer that a fixed kettle temperature with a fixed column pressure will not always give the desired constant vapor pressure bottom product. This is true because in practice there are times when the column operates with a very low reflux ratio, or what is more common, the composition of the feed stock changes. From a study of the information available, methods of effecting corrections for these variations are devised, so that the average of the product produced will meet the vapor pressure specifications.



Generally these corrections are the result of correlating operating data with laboratory determinations of the vapor pressure of the product. At certain periods of the day the vapor pressure normally rises due to atmospheric conditions, and modifications in the kettle temperature or column pressure are correspondingly made so as to correct for such variations. Eventually such modifications become a part of the operating routine. In the majority of cases, however, after this routine is once established, little, if any, laboratory control is applied, it being assumed that the operation will average itself out over a period of time. As a result, tanks of gasoline about to be shipped are rejected, or are accepted under a price penalty, or in some cases, must be blended with new make in order to meet the vapor pressure requirements. Often it is even necessary to re-process a quantity of the supposedly finished product. Such procedures are costly and rightly looked upon with disfavor by the management.

The vapor pressure of natural gasoline is its most distinguished characteristic. In fact, vapor pressure forms the basis for grading, and it is sold and bought upon the value of its vapor pressure. And yet there is nothing about the stabilizer unit that directly indicates the vapor pressure of the product being produced. It is true that column pressure and temperatures are recorded at all times, and the quantity of stock metered, but without consulting correlated laboratory data, which possibly are hours, days or even weeks old, there is no way of instantly telling the vapor pressure of the product being made. Under such conditions even an operator with a "photographic" memory can hardly be expected to have the stabilizer always "on the line" insofar as vapor pressure is concerned. If the operation is smooth and not troublesome, little further thought will be given the unit, although it might be producing a non-specification product.

There is now no need for further operations of this type, as there has been developed and commercially perfected a vapor pressure recorder that makes the vapor pressure available instantly at any time. All that is necessary to ascertain the vapor pressure of the product is to consult a chart similar to those obtained from conventional pressure recorders. The vapor pressure may be read directly from it, and the chart record makes available the previous values from the time the chart was placed on the instrument. With this chart of vapor pressure, the operator can follow the trend, and can correct and control the operation in a positive manner.

The chart shown in the illustration is a reproduction of one obtained while attempting to produce a 7-lb. vapor pressure product from a stabilizer. Had this record been available to the operator it is evident that it would have furnished an excellent guide and hence resulted in a more uniform product.

*Industrial Engineers, Inc., Los Angeles, California.

George Legh-Jones Assistant to Sir Henri Deterding

George Legh-Jones, president of the Shell Oil Company, will leave shortly for London, where he will take an important part in the management of the world-wide interests of the Royal Dutch Shell Group. He will be Sir Henri Deterding's immediate assistant and will be directly in charge of the Royal Dutch Shell Group's interests in both North and South America.

Legh-Jones came to the Pacific Coast in 1922 as president of Shell Oil Company (then Shell Company of California). At that time the company's interests represented only a small part of what they are today. Prior to 1922 the company had oil production only in the Coalinga oil field and refineries at Martinez and Coalinga, California, while its marketing activities were restricted to relatively few of the major metropolitan centers on the coast. Today Shell Oil Company has five refineries, at Coalinga, Martinez, Wilmington, Dominguez, California, and Shellburn, British Columbia. It has substantial oil production holdings in every important field in California and its marketing activities extend throughout the states of California, Oregon, Washington, Nevada, Arizona, New Mexico, Idaho, Montana, Utah, and Wyoming, the Territory of Hawaii, and the Province of British Columbia.

GEORGE LEGH-JONES

The Shell Building in San Francisco, one of the landmarks of the city, was completed in 1930. Legh-Jones was directly responsible for the conception and completion of this magnificent structure.

Legh-Jones for many years has occupied a leading position in the affairs of the petroleum industry as a whole. He has long been a director of the American Petroleum Institute. The esteem in which he is held by the industry and by the administration was notably expressed last year by his selection as chairman of the Pacific Coast Regional Marketing Committee under the National Code of Fair Competition for the Petroleum Industry.

He also has been one of the chief proponents of the Pacific Coast Petroleum Agency which recently was successfully developed and inaugurated and is designed to stabilize the Pacific Coast petroleum industry.

The directors of Shell Oil Company have announced the appointment of S. Belither to succeed Legh-Jones as president of Shell Oil Company. Belither has a background of many years' experience in all branches of the petroleum industry. For the past year he has been executive vice-president of Shell Oil Company, and prior to that time he held an executive position with Shell Union Oil Corporation in New York.

You furnished the conditions

WE BUILT THE VALVE

When your engineers began to improve Oil Industry processes, the available types of regulating valves were found inadequate. Higher pressure drops quickly cut away the valve plugs and seat rings.

Mason-Neilan Engineers realized that drastic changes were imperative, and started the experiments which resulted in the development of the present Parabolic Centroguide Valve, that eliminates wire drawing and cutting by removing the cause. Reduces flow resistance to a minimum and increases the valve capacity by preventing eddy currents and flow turbulence. Furthermore, this valve is capable of throttling small flows or full pipe capacity.

Like all Mason-Neilan Regulators and Instruments, the Parabolic Centroguide Valve was developed *in and for* the Oil Industry by engineers who know its specialized needs. For exact control of pressure, temperature, rate-of-flow and liquid level—install Mason-Neilan Control Equipment.

MASON-NEILAN
REGULATOR COMPANY

1190 Adams Street, Boston, Mass.

BALTIMORE, Whitaker Building	Morton Mc I. Dukehart & Co.
CHICAGO, 435 North Michigan Avenue	Gordon Thomason, Manager
HOUSTON, 1400 Conti Street	Maintenance Engineering Corp.
LOS ANGELES, 2446 Enterprise St.	Tunnell & Co.
MONTREAL, Canada, 620 Cathcart St. W.	Maurice Peller, Manager
NEW YORK, 19 Rector Street	A. L. Krook, Manager
PHILADELPHIA, 930 North Front Street	Baeuerle & Morris, Inc.
PITTSBURGH, Clark Building	Bruce Irwin, Manager
ST. LOUIS, 2726 Locust Boulevard	O'Brien Equipment Company
SYRACUSE, N. Y., 640 Gurney Building	O'Brien Steam Specialty Company
TULSA, 409 East Archer Street	Moorelane Company

YOU CAN BE SURE OF MASON-NEILAN PRODUCTS

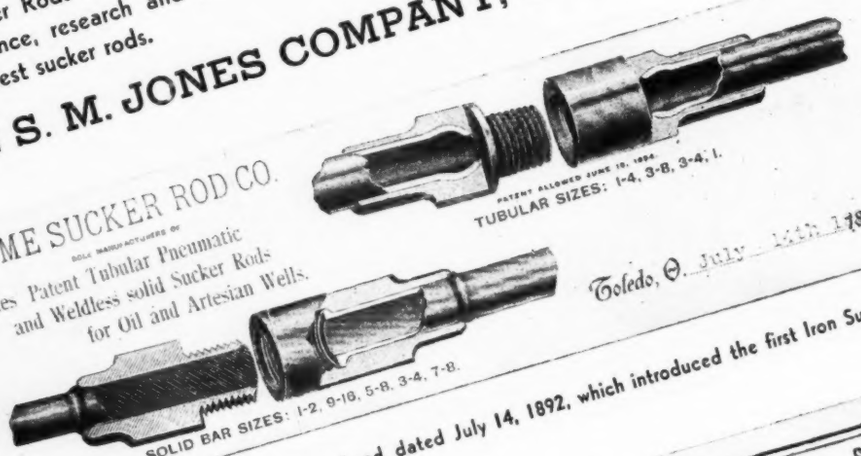
In 1892 ... JONES
THE PIONEER MANUFACTURER OF THE FIRST IRON SUCKER ROD ....

blazing the trail of progress even in this early day, Jones—always a leader—manufactured and introduced the first iron and steel sucker rod . . . acclaimed by thousands of oilmen as a vast improvement over the old wooden sucker rods which were formerly used. Thus began the first of a long line of Jones Sucker Rod improvements, modified down through the years until we reach the celebrated—

Jones High Manganese Full-Normalized Sucker Rod of Today

—Produced in the World's Largest Sucker Rod Plant where the metallurgical quality of Jones Sucker Rods is constantly maintained with the precision of a laboratory formula—where science, research and skilled craftsmen unite in producing a complete line of the world's finest sucker rods.

THE S. M. JONES COMPANY, TOLEDO, OHIO


ACME SUCKER ROD CO.
SOLE MANUFACTURERS OF
Jones Patent Tubular Pneumatic
and Weldless solid Sucker Rods
for Oil and Artesian Wells.
PATENT ALLOWED JUNE 10, 1884
TUBULAR SIZES: 1-4, 3-8, 3-4, 1.
SOLID BAR SIZES: 1-2, 9-16, 5-8, 3-4, 7-8.
Toledo, O. July 14th 1892.

Reproduction of an old Jones letterhead dated July 14, 1892, which introduced the first Iron Sucker Rods to the oil industry.

ROCK, AUGUST 20, 1899.
RACE RIOTS IN GEORGIA
SERIOUS TROUBLE AGAIN BREAKS OUT AT DARIEN.
Armed Negroes Massed Outside the Town Will be Attacked by a Strong Force of Citizens and Troops Today. Prisoner Kills One Officer and Wounds Another. General Call for Militia.
Atlanta, Ga., Aug. 20.—There is a renewal of the race trouble at Darien, Ga., and Governor Candler has again been asked to send troops there to prevent an outbreak. A few days ago Henry Dalegal was arrested at Darien on a charge of assault and a lynching was prevented by the efforts of the Governor in sending 20 members of the First regiment who brought the prisoner to Atlanta, and left a detachment on guard at Darien.
Tuesday Joseph Townsend was killed and Hopkins was wounded in the shoulder by John Dalegal, whom, they were trying to arrest. Sheriff Blount, of McIntosh county, wired Governor Candler to-day urging that more troops be sent to Darien, Ga., who is in command of Colonel Lawton and Blount's message which were sent to him. Governor Candler has referred Sheriff Blount's message to Colonel Lawton and ordered the Liberty county independent troops to be in readiness to move.
A tug left at noon for Savannah with the riot prisoners on board. It was thought best to take them there for safekeeping in order to avoid any possible attempt to rescue and for the further reason
S. M. Jones, President. D. E. Jones, Vice-President. S. L. Good, Sec'y-Treas.
BELL 'PHONE 1341 — HARRISON 'PHONE 1075.
The Acme Sucker Rod Co.
Manufacturers of
Up-to-Date Oil Well Appliances.
Office and Factory 600-616 Segur Avenue.
Toledo, O.

Jones Sucker Rods have always been "Up-To-Date". Witness the reproduction of this advertisement run in The Derrick in 1899 featuring "Up-To-Date Oil Well Appliances".

S. A. Knisely Advertising and Sales Promotion Manager Republic Steel

Stanley A. Knisely, of Cleveland, Ohio, has been appointed advertising and sales promotion manager of Republic Steel Corporation, with headquarters at Youngstown, Ohio. He succeeds L. S. Hamaker, who recently was made vice president and general manager of the Berger Manufacturing Company, Republic subsidiary, of Canton, Ohio.

Knisely entered newspaper work in his home city of Canton, Ohio, and later held the positions of city editor and telegraph editor of the Cleveland Plain Dealer. He left the newspaper field to become advertising and sales manager of the National Paving Brick Association, with headquarters in Cleveland. After six and a half years in that position, Knisely became director of advertising research for the National Association of Flat Rolled Steel Manufacturers and served seven years in that capacity.

Bridgeport Opens New Branch Store at Chase, Kansas

To better serve its patrons in the territory between McPherson and Russell, Kan., where branch stores have been in operation for several years, the Bridgeport Machine Company, Wichita, Kan., has now opened a store at Chase.

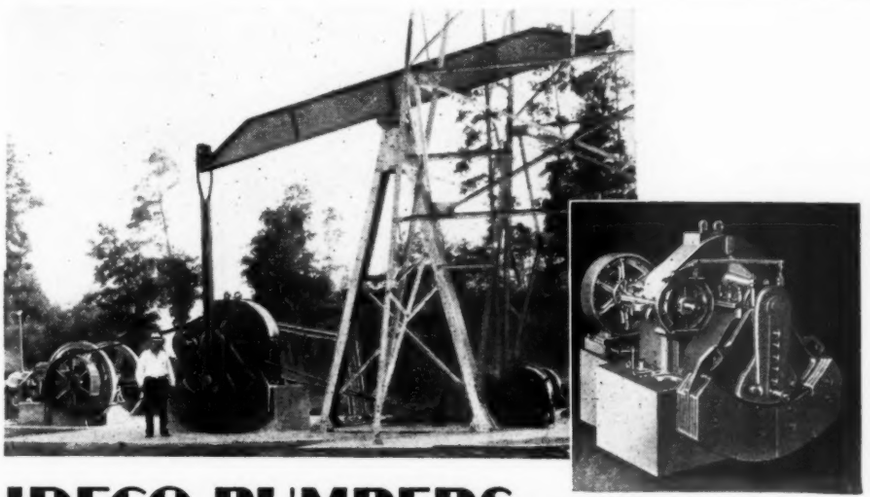
Hal Craig, who has represented the company at several Texas points, and more recently at McPherson, is in charge of the Chase store, where the customary Bridgeport service will be available day and night.

Aquagel and Baroid drilling muds, American Wire Lines, National Tube Company products, rental tools, used equipment, and the company's own line of drilling, fishing and production equipment, which is manufactured at Wichita, are carried at the new store.

Joint Research Committee A.S.M.E.-A.S.T.M. Extends Activities

The A.S.M.E.-A.S.T.M. Joint Research Committee is extending its fields of active interest to include matters of pressing industrial and engineering importance. The subcommittee on oil refinery problems is working out an acceptable plan for procurement of experimental and operating information on still tubes for the oil-cracking industry. Petroleum refinery engineers, tube makers, and the joint committee are coöperating in the effort to apply the most modern methods of evaluation of properties and performance toward the development of better tubes and their most economical engineering application.

Another activity, also with a bearing on the oil industry, in relation to dewaxing problems, but also with many other industrial bearings, is the correlation of data on properties of metals at sub-zero temperatures. Many of the members of the joint committee are engaged in getting new data in this relatively unexplored field, and the formation of a new subcommittee to deal particularly with this problem will serve to unify these data and make them more generally available. Still another new activity is a similar correlation of data on seizure, i. e., the effect of temperature on metal-to-metal wear, galling and sticking. Users and makers of valves that operate at elevated temperatures find this an important problem in which available information is chiefly of an empirical nature.



IDECO PUMPERS are the *profitable* oil getters!

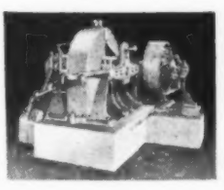
Left: A 100% Ideco-equipped pumping installation from engine to derrick.

Above: Ideco geared pumper SS-100.

YOUR pumping job is too important to be handled by equipment that you can't depend on absolutely for trouble-free service. Why not guard against periodic shut-downs and continuous pumping losses by insisting on the use of only Ideco *geared* Pumpers. They're made for doing the job with the utmost efficiency—and for doing it at lowest possible cost.

Let us tell you about them and why they are the most profitable oil getters you can put on your wells. Built in a complete line—20 to 100 h.p. May be equipped with sprocket for operating tubing hoist or a tug rim for driving bull wheel. Write our nearest branch for bulletins 100 C, D and E.

THE INTERNATIONAL DERRICK & EQUIPMENT CO.
Beaumont, Texas Columbus, Ohio Los Angeles, Calif.
Branches in all Leading Oil Centers



Back side of unit, showing new Ideco 3-wing backside crank for multi-well pumping. A big feature!

IDECO
BOYKIN

Every Pumping Well Will Save You Money if Equipped with AXELSON Pump and Sucker Rods

AXELSON MANUFACTURING CO.
P. O. Box 710, Vernon Station, Los Angeles

St. Louis 50 Church St., New York Tulsa

Mid-Continent and Eastern Distributor:
Frick-Reid Supply Corporation

Rocky Mountain Distributor:
Great Northern Tool & Supply Company

LUFKIN TAPES

"Atlas"
The World's Best Gauging Tape

"Challenge"
for Engineering, Strapping and General Measuring

Send for Catalog covering complete line

THE LUFKIN RULE CO. SAGINAW, MICH.
106 Lafayette St., New York City

Shipment by Plane to West Indies for Oil Refinery Disabled by Flood

A 3000-mile aerial relay race against time, from Schenectady, New York, to Aruba, an island in the Dutch West Indies, took place recently when an 808-lb. shipment of electric-motor coils was rushed by plane from the General Electric Company's headquarters to the Lago Oil and Transport Company, a refining concern owned by Standard Oil

Start of 3000-mile aerial relay. Left to right: F. W. Hurlbert, I.G.E., New York City; G. R. Weeks, Standard Oil of N. J., Bayonne; J. A. H. Torry, I.G.E., Schenectady; Pilot, Ben Jones, Schenectady Airport.

of New Jersey, 50 miles north of the coast of Venezuela. The refinery, its motors crippled by flood, had been forced to shut down pending arrival of the new coils.

To meet the emergency, General Electric produced the coils—a type for which it was even necessary to manufacture the wire of which they were made—in three days' total time, although the work involved would ordinarily require from two and a half to three weeks. As soon as production was completed, the coils were packed in compact cartons, each weighing less than 100 lb., and specially designed for air shipment, and were flown by plane to Newark, N. J.

There Standard Oil took over the shipment and placed it on an Eastern Air Lines plane bound for Miami, Florida. Upon reaching the Miami airport, the cartons were quickly transferred to Pan-American Airways for the journey across the Caribbean to Kingston, Jamaica, and thence to Barranquilla, Colombia. From that point the consignment was transshipped on a specially chartered plane to the island of Aruba.

A.S.M.E. Officers Nominated

Nominations for officers of the American Society of Mechanical Engineers for 1935 were announced at a recent meeting of the nominating committee held at Denver, Colo., during the semi-annual meeting. Election will be held by letter ballot of the entire membership, closing on September 25, 1934.

The nominees as presented by the regular nominating committee of the society are:

President—R. E. Flanders, president, Jones & Lamson Machine Company, Springfield, Vermont.

Vice-presidents—E. W. O'Brien, editor, Southern Power Journal, W. R. C. Smith Publishing Company, 1020 Grant Building, Atlanta, Ga.; James H. Herron, president, James H. Herron Company, 1360 West 3rd Street, Cleveland, Ohio; H. R. Westcott, president, Westcott & Mapes, Inc., 139 Orange Street, New Haven, Conn.

Managers—B. M. Brigman, dean, Speed Scientific School, University of Louisville, University Campus, Louisville, Ky.; Alfred Iddles, vice president, United Engineers & Constructors, Inc., 1401 Arch Street, Philadelphia, Pa.; J. W. Haney, professor, University of Nebraska, Lincoln, Nebraska.

TRADE LITERATURE

ENTIRELY NEW METHOD OF PUMPING WELLS OF ANY DEPTH—Kobe, Inc., the California oil equipment manufacturers, have developed a method of pumping oil wells that is fundamentally different from others, but easy to understand by anyone familiar with ordinary field conditions. The Kobe method successfully utilizes fuel operations, and the manufacturers state that it eliminates the use of much massive surface equipment; provides hydraulic power at the pump, and automatic production control; and attains highest efficiencies. The Kobe company further claims that the method will substantially lower the cost of pumping—that field records have established this fact. The manufacturer has issued a bulletin, number 34-100, which fully illustrates and describes the new Kobe pump and the method of using it. Copies of this bulletin will be supplied to anyone promptly upon request. Write Kobe, Inc., Huntington Park, California.

A 12-PAGE BULLETIN descriptive of Lane-Wells liner hangers, setting tools and adapters recently has been issued. In addition to descriptions of the various tools mentioned, engineering drawings, operating instructions, and general information are included. Copies are available upon request to the manufacturers, the Lane-Wells Company, 4439 Santa Fe Avenue, Los Angeles, California.

A novel piece of valve literature is the 12-in. cut-out replica of a Jenkins Standard Iron Body Gate Valve recently prepared by Jenkins Bros., 80 White Street, New York, N. Y. This cut-out is next best to having the real Jenkins Gate for inspection, as it provides an exact reproduction of both the exterior and the mechanism of a big, heavy Jenkins Valve. An accurate listing of the features of Jenkins design and construction also is given.

BULLETIN NO. 134 of the National Supply Companies contains information on the Hydraulic Rotary Machine, the Universal Pipe Gripper, Type C, and the Twin Cylinder Hydraulic Snubbing Jack. The bulletin is being sent free to those requesting it.

INTRODUCING several new products, The Shull Perforating Company, Inc., Long Beach, Calif., has issued a catalog of interest to drilling operators. The catalog completely describes the various products of the company, which include a new swab, two types of casing perforators, a new type of pressure bailer, a pressure perforation cleaner, tubing slips, collar locators, pipe and tubing grabs, bridging plugs, casing cutters and line spoolers. A copy of the catalog may be obtained by writing to Shull Perforating Company, Inc., 2750 Cherry Avenue, Long Beach, Calif.

THE VIGILANT FEED-WATER REGULATOR and other steam specialties made by the Chaplin-Fulton Manufacturing Company are represented in a completely illustrated and well-arranged catalog of 60 pages. In this particular field, besides the vigilant feed-water regulator, the line comprises the Fulton boiler-feed pump governor (differential and constant-pressure types), Fulton gas-fuel boiler governor, altitude governor, vacuum pump governor (single diaphragm and duplex types), water reducing valve, steam reducing valve, constant pressure pump governor, Bingham gauge cock, and Fulton ejector. The Chaplin-Fulton Company also manufactures an extensive line of equipment for pressure control.

AMERICAN STEEL SHEETS

FOR ALL KNOWN USES

KEYSTONE COPPER STEEL — AMERICAN SHEET AND TIN PLATE COMPANY

In the Petroleum Field

For tanks, drums, roofing and siding of shops, sheds, boiler and belt houses, and general sheet metal work, Keystone Copper Steel *gives maximum rust resistance.*

Insist upon AMERICAN Black Sheets, Keystone Rust Resisting Copper Steel Sheets, Apollo Best Bloom Galvanized Sheets, Galvannealed Sheets, Heavy-Coated Galvanized Sheets, Formed Roofing and Siding Products, Tin Plates, Terne Plates, Black Plate, Etc.

Write us relative to your sheet steel requirements. This Company also manufactures U S S STAINLESS and Heat Resisting Steel Sheets and Light Plates for all purposes.

AMERICAN SHEET AND TIN PLATE COMPANY, Pittsburgh, Pa.

SUBSIDIARY of UNITED STATES STEEL CORPORATION

Look for the *Arm-and-Hammer*

ARMSTRONG BROS.

Stronger **CHAIN TONGS**

Standard or Reversible Jaws

DESIGNS that give increased bearing of jaws on the bar. Chains that are proof-tested to two-thirds catalog strength (3,600 to 40,000 lbs.). Special steels for each part. Drop-forgings, accurately machined, heat-treated, hardened, tempered and tested. All of these features combine to make ARMSTRONG BROS. TONGS strong, longer wearing, finer tools in every way. All standard types. Sizes for all pipe from 1/8 in. to 18 in.

Write for Catalog

ARMSTRONG BROS. TOOL CO.

"The Tool Holder People"

331 N. Francisco Ave., CHICAGO, U.S.A.

Mid-Continent Representative:

EARL WADDELL, Fair Bldg., Fort Worth, Tex.

Applying Simple Physical Principles to Practical Problems

By
W. C. LANE
Electrical Engineer

SOME years ago an article in a farm magazine concerning a rural electric power plant had a statement that if one has a 2-hp. waterfall on one's farm one can install an electric generator and drive all the machinery about the place. Among the things enumerated that could be done were lighting the house and barn, turning the grindstone, churning, shelling corn, grinding feed, filling the silo, threshing, and even milking the cows. All this work was to be accomplished with a 2-hp. waterfall.

It was evident that the writer had exaggerated notions on what can be done with a limited amount of power; but his ideas were no more vague than are many of those one encounters almost daily. To illustrate, recently a machinery company received a request for information concerning a drive for a reciprocating pump. The customer stated that inasmuch as the pump must deliver 50 hp. and he had on hand a 10-hp. motor, he should like to procure a 5-to-1 drive in order that the power of the motor might be stepped up. When questioned, he presented the following argument: "If I have a car with a 5-to-1 gear ratio and you have a similar one with a 3-to-1 ratio, I can pull your car with ease. Am I not stepping up the power?" In another case a salesman who had just returned from a field trip asked for information concerning an air compressor. When pressed for details he stated that a prospective customer was planning to apply a vacuum to some stripper wells and that they had talked the matter over and decided that a 40-lb. vacuum should be used.

Quite sure of his grounds was the purchaser of a gas engine who was dissatisfied with its operation because it exploded regularly. He believed that in order for an engine to "save gas" it should miss an explosion now and then. Not long ago the writer was present at a demonstration of a device for removing paraffin from flow lines. A chemical compound, probably lye and ground aluminum, was dumped into water in a closed vessel and after a certain pressure had been built up as a result of the chemical action the content was supposed to be discharged through the line. As no suitable flow line was available the charge was allowed to escape into the open air and in doing so made a rather impressive spectacle. Upon making inquiry about the weight of the charge and the heat units set free it was explained that the energy was equivalent to that contained in a piece of coal weighing between two and three pounds. It is difficult for one to imagine that the amount of energy released would be very effective in opening up a long flowline on a snowy day.

Such instances lead one to the conclusion that many of us spend a prodigious amount of time talking over people's heads; that the general confusion of ideas relating to the simpler physical principles on which much of our machinery and many of our processes are based is greater than we realize. Many who are able to do so, do not take the trouble to differentiate between such terms as energy and power, power and torque, work and energy, horsepower and horsepower-hour, and similar physical terms closely related but of dissimilar meaning. One frequently encounters ambiguous claims made in some of our best semi-technical articles that mean nothing definite when analyzed, but are easily misconstrued and lead to erroneous conclusions. A statement taken from a reprint of an article published in a current number of a trade paper illustrates the point in mind. In commenting on the power required to pump oil by means of a certain pneumatic device the statement is made: "Calculated requirement is approximately one hp. per ten bbl. lifted." Unless the time spent in lifting the ten bbl. and the lift are given the claim is meaningless. If the work was done in one hour the power requirement was .1 hp. or .0746 kw-hr. per bbl., and the lift cannot be more than 700 or 800 ft.—unless it be assumed the device is more than 100 per cent efficient. On the other hand, assuming that ten bbl. of oil per day is pumped per each hp. capacity of the device as calculated from an indicator card, 24 hp-hr., or approximately 18 kw-hr., is the amount of energy involved. This is 2.4 hp-hr. or 1.8 kw-hr. per bbl. lifted — a reasonable value to expect. However, since the lift is not given it is impossible to determine the actual efficiency, but if we assume that it is 5,000 ft. the efficiency will be about 30 per cent.

When a bbl. of oil is taken from the earth by mechanical means the work done is equal to the weight of the oil multiplied by the vertical distance through which it is lifted. For example, 600,000 ft.-lb. of work is done in lifting a bbl. of heavy oil weighing 330 lb. 2000 ft., and the work done is independent of the time spent in performing the operation. When work is done at the rate of 33,000 ft-lb. per min. the power, that is, the rate of doing the work, is said to be one horsepower. If the bbl. of oil is lifted the entire distance in one min. the horsepower required will be 660,000 divided by 33,000, or 20; if accomplished in ten min. the rate is only one-tenth as great and the horsepower will be two.

Energy is the capacity for doing work a body or a quantity of a substance has by virtue of its position, motion or physical condition. The bbl. of oil mentioned above, when it is at the well head has, by virtue of its position, 660,000 ft-lb. of energy with respect to the bottom of the hole. If a turbine could be attached to the bottom of the tubing and the oil poured back down the hole, neglecting friction, it will do the same amount of work on the turbine as that which was spent in lifting it, but the power will depend on the rate at which the oil is released. The power generated will be one hp. or 20 hp., depending on whether 20 min. or one min. is involved in the operation. Gas entrained in oil has energy to do work; when allowed to expand and lift oil the power it will have will depend on the rate of the procedure.

In the case of the turbine the term torque refers to the force turning, or tending to turn, the wheel. The unit of torque is the ft-lb. and is equivalent to a force of one lb. acting at one ft. radius. Torque will be produced by the oil whether the turbine rotates or not but in order to have power the wheel must turn and work be done. A small torque acting at a high speed may produce the same amount of power as a large torque acting at a slow speed.

The principles involved in the following paragraphs are frequently misunderstood.

The pressure exerted by a column of fresh water on the bottom of an open vessel is equal to .434 lb. per sq. in. for each ft. of the vertical depth or 434 lb. per 1000 feet. The

work done in lifting one bbl. of water 1000 ft. is the same as that which would be expended in pumping one bbl. of water against a pressure of 434 pounds. In other words, neglecting losses, the horsepower required to pump a given quantity of water against a certain pressure is equal to the product of the weight of the fluid moved per min. and the pressure, divided by the product of the constants, .434 and 33,000. Since oil is lighter than water it takes less energy to pump it, the exact amount depends on the specific gravity of the oil. Conversely a pumping unit capable of exerting a certain horsepower will pump more oil against a given pressure than it will water.

While inspecting an electric drilling rig I learned that the drilling and hoisting motor had ample power but the owner complained that it was "slow power." He believed that if he had purchased a motor of the same hp. capacity but rated at 875 instead of 695 r.p.m., the hoisting speed would be satisfactory. He felt sure that an 875-r.p.m. motor must be stronger than one rated at only 695 r.p.m. Obviously, if he had replaced the 695-r.p.m. motor with one rated at 875 r.p.m. without changing the sprocket ratio of the drive, the hoisting speed would have been increased; but increasing the rate at which the work is done will increase the load on the motor. In other words, "slow power" means that if the motor is fully loaded and it does not hoist the load as rapidly as the operator desires, the remedy is to procure a larger motor and, if necessary, change the sprocket ratio of the drive so as to increase the rope speed.

The hoisting ability of a motor to be used on intermittent work, such as hoisting drill pipe in which the time element is of vital importance, depends on the hp. available at the speed of its maximum running load. This is numerically equal to the product of the normal hp. rating, the maximum running torque, and the speed at the maximum running torque, divided by the product of the full-load torque and the rated full-load speed. These quantities can all be determined from the information given on an A.P.I. Standard Performance Data Sheet for an induction motor. Calculations based on this principle were made for four drilling motors used to operate light rotary rigs and the results and the data on which the results are based are tabulated below. Of course, the temperature developed by each at its rated load must be taken into consideration in making a final analysis. It would be of much assistance if the A.P.I. sheets would include a statement concerning the actual load at which a motor may be operated continuously with a standard increase in temperature. Ordinary guarantees state that the temperature shall not exceed a certain value, but in numerous cases observed the temperature does not approach it.

Hp. Rating	*Synchronous Speed*	*Full-Load Torque*	*Max. Running Torque*	*Full-Load Speed*	*Speed at Max. Torque*	*Calculated Hp.*
125	900	740	2840	888	648	350
150	900	896	3200	879	729	440
125	720	950	3325	690	439	280
150	900	850	2790	878	750	420

In hoisting drill pipe with a d-c motor, such as in the case of a Diesel or gas-electric rig, maximum pull may be applied to a frozen string of pipe and maintained for an indefinite time. The only energy expended while the pipe is at rest but under tension is that incident to forcing the electric current through the ohmic resistance of the mains serving the motor and the motor armature. This requires only a small voltage so that the load on the engine driving the generator is small. When the pipe starts to move the current will decrease automatically unless the generator voltage is increased. It is possible to increase the voltage at a uniform rate so that the current supplied to the motor will always be that which produces the maximum torque. In this way the load may be accelerated uniformly until a rope speed, corresponding to that which puts the maximum permissible load on the engine driving the generator is reached. It is evident that in the case of a partially disabled engine the rate of pulling a string can be made as low as desired and since, with a given string the rope speed will determine the hp., the load can always be kept within the capacity of an engine. When a mechanically-connected internal combustion engine has reached the limit of its capacity with the lowest drawworks speed provided, it can do no more. The speed of an engine can not be reduced in order that the rate of the work may be reduced, for the torque it will produce diminishes with a reduction in speed. In reality the d-c. motor imparts to the rig any number of speeds below the lowest provided by the drawworks so that the output of a generator driven by a very small engine will actually lift as heavy a load as if the generator were driven by a large engine. The same work is done, but it takes longer to do it so the power required is less. With a d-c. motor there is no occasion to slip the clutch or take a run at a load as on a mechanically connected rig.

The confusion of ideas pertaining to mechanical units noted above also exists with respect to heat units and to elementary heat problems. It is well for one to develop his imagination until he is able to picture the units involved and to compare one with another. Laying aside technicalities, the heat unit in everyday use, the British Thermal Unit, referred to as the B.t.u., is the amount of heat required to raise the temperature of a lb. of water one degree fahrenheit. One lb. of good coal will produce 13,000 of these units under ideal conditions of combustion. Ordinary natural gas contains about 1000 B.t.u. per cu. ft., but the term "gas," like the term "gasoline," is an indefinite quantity and may vary much in value. A kw-hr. of electricity when converted into heat represents 3415 B.t.u. One other principle should be kept in mind, and that is that there is a certain number of B.t.u. released or absorbed whenever one lb. of a given chemical compound is involved in a reaction. In the case of a lye-ground aluminum reaction, 700 B.t.u. are released per pound.

Recently a city gas salesman was heard to tell a customer that gas at 45 cents per thousand cu. ft. is cheaper than coal at $6.00 per ton. The gas in use is said to have 1050 B.t.u. per cu. ft., and for purposes of analysis assume coal that produces 12,500 B.t.u. per pound.

$6.00 will purchase 2,000 lb. of coal
or ($6.00 ÷ .45) = 13,333 cu. ft. gas.
2,000 × 12,500 = 25,000,000 B.t.u. coal.
13,333 × 1050 = 14,000,000 B.t.u. gas.

Doubtless the combustion of the gas is more nearly perfect but on the basis of heat units only, it appears that for almost any reasonable furnace efficiency assumed the coal is the cheaper.

The compound known as thermit has been offered to the trade for the removal of paraffin from the walls of oil wells. Thermit is a mixture of iron oxide and ground aluminum. An experienced well shooter on one job with which the writer was associated was in great fear of the material until some of it was placed on a flat rock and it was demonstrated that the chemical action could not be started with a gasoline blow torch. The temperature resulting from the chemical reaction is said to be 5400 deg. fahr., and 1665 B.t.u. are released per lb. of the mixture. The advocates of the method claim that a 75-lb. shell when ignited under about 100 ft. of water is very effective in melting the paraffin so that it can be bailed out. According to an old hard-rock miner, the diameter of the hole of a normal well that has been shot is probably about 18 inches. Simple arithmetic will show that the heat released by a 75-lb. shell when applied to heating a column of water 100 ft. deep and 18 in. in diameter will

Meddler-Proof

FULTON Spring-Type Regulator

LIGHT, compact, and easily transported, yet sturdy, dependable, and durable in hard use, the Fulton Spring-Type Regulator is recommended for exposed and remote locations. It is self-protecting to an uncommon degree—less subject to accidental disturbance or even intentional meddling than a lever-type regulator—and is very simply designed for quick connection. The high-pressure type will take any inlet pressure up to 300 pounds and reduce to a constant pressure anywhere between 10 and 50 pounds, as desired. Low-pressure type is adapted for inlet pressures up to 50 pounds and will reduce to desired pressure not exceeding one pound. Full information on this and other C-F regulators for all requirements of gas control will be mailed on request.

The Chaplin-Fulton Manufacturing Company
28-40 Penn Avenue Pittsburgh, Pa.

Petroleum Production Technology

from exploration to the finishing of wells

THIS IS A REVIEW and reference work of fundamentals, problems, methods and equipment—for all interested in a broad, practical understanding of petroleum production—covering those practices connected with the construction of wells, ready to produce oil.

New Second Edition

Petroleum Production Engineering
OIL FIELD DEVELOPMENT

By LESTER C. UREN
Professor of Petroleum Engineering, University of California

531 Pages, 6x9 • 258 Illustrations • $5.00

This is the first book of a two-volume edition, revised and enlarged to cover the far-reaching advances of recent years in this field. This book, complete in itself, gives a practical treatment of every phase of petroleum production engineering up to the point at which the wells are ready to produce. It introduces the fundamentals of field location and covers thoroughly the problems, methods and equipment of oil field development and modern deep-well drilling. • Every process and method of any consequence is fully explained and complete descriptions are given with illustrations of all commonly used oil field equipment, tools and appliances. In assembling this book an effort has been made to develop a well-balanced treatment that does not unduly stress some topics nor slight others.

Chapter Headings

1. *Properties, Occurrence and Associations of Petroleum.*
2. *Petroleum Exploration Methods.*
3. *Acquisition of Title to Oil Lands.*
4. *Developing the Field.*
5. *Drilling Equipment and Methods; General Features.*
6. *Churn Drilling Equipment and Methods.*
7. *Rotary Drilling Equipment and Methods.*
8. *Casing, Casing Appliances and Casing Methods.*
9. *Fishing Tools and Methods.*
10. *Oil-field Hydrology; Exclusion of Water from Wells.*
11. *Finishing the Well.*
12. *Well Records.*

Order from

THE PETROLEUM ENGINEER PUBLISHING COMPANY
Tower Petroleum Building DALLAS, TEXAS

raise the temperature 11 deg. fahrenheit. It seems obvious that soaking the formation with water having only this increase in temperature will have little virtue. In a series of tests made by a major oil company several years ago the temperature of several wells heated with thermit was measured by means of a resistance pyrometer. The increase was found to vary from 8 to 28 deg. fahr. in the wells tested when measured about ten min. after the shot was fired. On similar wells having only a few ft. of oil in them it was found that energy applied at the rate of 20 kw. for four hours increased the temperature about 100 deg. fahrenheit. This represents 283,200 B.t.u.

One is asked frequently about the relative economy of electricity and gas for heating the dog house of a drilling rig. Let it be assumed that a 10-kw. electric heater is to be used and that electrical energy will cost 1½ cents per kilowatt-hour. This is to be compared with an equivalent amount of gas with 1050-B.t.u. gas at 25 cents per 1000 cu. feet.

10 kw-hr. for 24 hr.	= 240 kw-hr.
240 at 1½ cents	= $3.60 per 24 hr. for electricity
240 × 3415	= 819,600 B.t.u.
819600 ÷ 1050	= 780 cu. ft. gas equivalent
780 cu. ft. at 25 cents	= $0.19½ per day for gas.

It appears that electricity for heating purposes on the basis of heat units only will never be a formidable competitor for either gas or coal. However, on drilling rigs the conditions sometimes arise where it is economy to use electricity on account of its availability and safety. On one 2260-ft. cable-tool well drilled in the early spring in a cold climate 38 per cent of the total energy consumption was used in heating and lighting the rig.

There is one other physical principle not mentioned in the text books that manufacturers and supply venders should consider more frequently than they do. It has no name; it has to do with the physical operations involved in putting a device in service, removing it for repairs and reassembling, reinstalling or rerunning it. Many devices based on principles that are sound and which function perfectly on the drawing board, in the shop and in the hotel lobby are found to be worthless under actual working conditions. The governing factor may be the red mud of Southern Oklahoma, the hot sand of West Texas, the driving spray of the Louisiana coast or the stinging cold of Wyoming.

The Filtrol Company Adds to Plant Facilities

Construction of additional plant facilities by The Filtrol Company of Los Angeles was completed the middle of August. New buildings were built and new equipment installed, increasing the capacity of the Los Angeles plant approximately 50 per cent.

G. Howard Hutchins, president of The Filtrol Company, in speaking of their increased business, said: "We are selling 50 per cent more lubricating oil refineries than two years ago. Our customers now include not only leading refiners in the United States, but those of Europe, South America and even China. Although our present sources of raw material are adequate for some years to come, we are conducting negotiations for additional deposits."

The Filtrol Company manufactures an activated adsorbent called "Super-Filtrol" for lube oil filtration by either fractionation or by contact, and also manufactures and sells to animal and vegetable refineries an activated adsorbent under the trade name of "Neutrol."

Edward P. Spore Made Southwestern Representative Dayton Rubber

The Dayton Rubber Manufacturing Company, Dayton, Ohio, announces the appointment of Edward P. Spore as

EDWARD P. SPORE

district representative, to be in charge of distribution and sales of Dayton's complete line of V-belts and pulleys for all types of industrial service in the Southwest. Mr. Spore has long been associated with the power transmission field in the Southwest as representative of a leading transmission accessory manufacturer, and recently resigned from his former connection to take over his new activities with Dayton.

Governors Will Speak on Drake Well Park Program

Governor Pinchot, of Pennsylvania, and Governor White, of Ohio; Federal Oil Administrator Harold G. Ickes; President Axtell J. Byles, of the American Petroleum Institute, and Mayor Arthur G. Bellen, of Titusville, Pa., are to be speakers on the program of the Diamond Jubilee of Oil to be celebrated at Titusville August 24 to 27. At that time the Drake Well Memorial Park, builded about the site of this country's first commercial oil well, will be dedicated formally and presented to the State of Pennsylvania by the American Petroleum Institute.

This celebration of the petroleum industry's 75th anniversary will start Friday, August 24, "Oil Region Day," with a sightseeing tour of the Drake Well Memorial Park and other historic sites. The Diamond Jubilee of Oil Exhibition will be opened formally early in the afternoon. At night an historical pageant, "The Story of Oil," will be presented at the fair grounds.

Saturday, August 25, will be "Jubilee Day," with a parade in the afternoon and a pageant at night. There also will be band concerts in the park and the Diamond Jubilee Ball in the gymnasium of Colestock High School. Sunday, August 26, is to be "Old Home Day" with special church services, band concerts, and singing.

Monday, August 27, the 75th anniversary of the appearance of oil in the Drake well, will be celebrated as "Drake Day." Dedicatory exercises will be held in the afternoon, and mardi gras, fireworks, and band concerts at night.

Godfrey L. Cabot, Inc., Move Office

Godfrey L. Cabot, Inc., have announced the removal of their head office from the Old South Building, Boston, Mass., to 77 Franklin Street in the same city.

COOL AS A DRAUGHT
from a mountain spring
Gotkool
WATER CANS
& COOLERS
With the GOTT Water Cooler handy, you will always be assured of a fresh supply of pure drinking water kept delightfully cool — it's health insurance... Order one from your supply store today!
Gott
H. P. GOTT MFG. CO., Winfield, Kansas
KEEP PURE DRINKING WATER ALWAYS HANDY

THE *Standard* WATER CAN OF THE PETROLEUM INDUSTRY

AXELSON
heavy duty cage

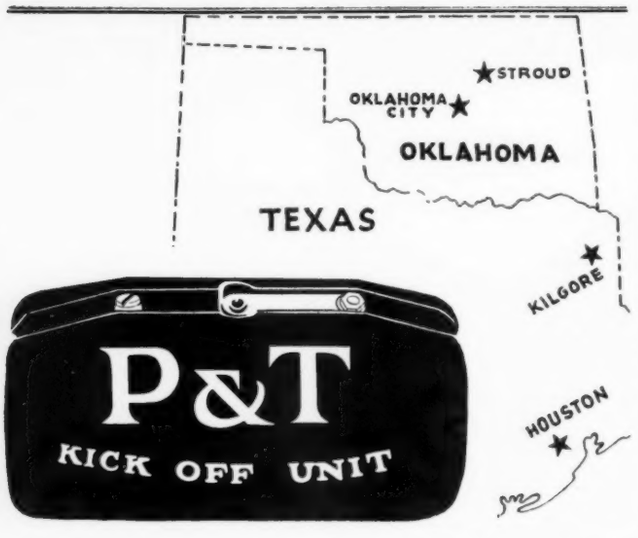
- Maximum fluid capacity
- Increased operating life
- Hardened interior surface
- Square milled, strengthened wings.

AXELSON
Manufacturing Company
P. O. Box 710 Vernon Station,
Los Angeles, California.
Tulsa St. Louis
50 Church St., New York City
Mid-Continent and Eastern Distributors:
Frick-Reid Supply Corporation
Rocky Mountain Distributor:
Great Northern Tool & Supply Co.

SPERRY-SUN WELL SURVEYING CO.
1608 WALNUT STREET, PHILADELPHIA, PA.
DALLAS, TYLER AND HOUSTON, TEXAS. TULSA, OKLAHOMA AND LOS ANGELES, CALIFORNIA
SURWEL (Gyroscopic) • **SYFO** (Ink Bottle)
UNDERGROUND WELL SURVEYING SERVICE

• HYDRAUGER •
MODERN HORIZONTAL BORING MACHINE
For Underground Installation of Pipe and Conduits. Avoids damage to costly pavements and saves time. Send for Bulletin.
HYDRAUGER CORPORATION, Ltd.
343 Sansome St. San Francisco, Calif.

Renew Your Subscription.. Now



FOR BETTER SERVICE

to our customers

EAST TEXAS—Price-Trawick, Inc., Kilgore. P. O. Box 1611, 219 S. Commerce St., Phone 179. Fred Price, Lee Delf and R. Woodward in charge of sales. Edward Riley in charge of store.

GULF COAST — Gulf Engineering Co., Houston. Preston 5890. P. O. Box 182. E. F. Goggins.

CALIFORNIA—Buck & Stoddard, Inc., Los Angeles.

OKLAHOMA CITY — Price-Trawick, Inc., 1111 S. E. 29th St., Phone 7-1761.

• • •

Be sure to have full details about P & T Kick-Off Units before going to the expense and trouble of tubing wells for gas lift.

No well has ever been found that would not start flowing with low pressure when equipped with P & T Kick-Off Units.

For details and descriptive information see our representatives.

Price - Trawick Inc.

STROUD pt OKLAHOMA

INDEX *to* ADVERTISERS

A

Allis Chalmers Mfg. Co.
American Cable Co.
American Hammered Piston Ring Co.
American Lubricator Co.
American Meter Co. 80
American Sheet & Tin Plate Co. 8
American Steel & Wire Co. 87
Armstrong Bros. Tool Co. 39
Axelson Manufacturing Co., Ltd. 87
86 and 91

B

Baker Oil Tools, Inc. 81
Baroid Sales Co. 52
Bradford Motor Works 64
Bridgeport Machine Company, The
Broderick & Bascom Rope Co. 1

C

Chaplin-Fulton Mfg. Co., The 90
Chapman Valve Manufacturing Co., The
Chemical Process Company, Inc., The 79
Clark Bros. Co.
Continental Supply Co., The 59
Cooper-Bessemer Corporation, The 37

D

Dresser, S. R. Mfg. Co. 13

E

Eagle-Picher Lead Company, The
Elliott Core Drilling Co. 7
Emsco Derrick & Equipment Co. 59
Ethyl Gasoline Corporation

F

First National Bank in Dallas 71
Frick Reid Supply Corp.

G

Gaso Pump & Burner Mfg. Co. 67
General Electric Co. 6
Gott, H. P., Mfg. Co. 91
Guiberson Corporation 5

H

Hazard Wire Rope Co.
Hughes Tool Co. Back Cover
Hydrauger Corp., Ltd. 91

I

International Derrick & Equipment Co. 85
International Harvester Company of America 69

J

Jones & Laughlin Steel Corporation
Jones, S. M., Co., The 84

K

Kobe, Inc. 20-21

L

Landis Machine Co., Inc.
Lane-Wells Co. 77
Leschen, A., & Sons Rope Co. 10
Linde Air Products Co. 47
Lufkin Foundry & Machine Company 45
Lufkin Rule Co. 86

M

Magnolia Petroleum Co.
Martin-Decker Corporation 19
Mason-Neilan Regulator Co. 83
Mepham, Geo. S., & Co. 70
Metric Metal Works 8
Merco-Nordstrom Valve Co. Front Cover
Moore, Lee C., & Co.
Muskogee Iron Works 3

N

National Supply Companies, The 73
National Tube Co.
National Tube Co. (Stainless)

O

Oil Well Supply Co. 50-51
Oklahoma Gas & Electric Co. 74
Oxweld Acetylene Company 47

P

Patterson-Ballagh Corp. 4
Petroleum Rectifying Co. 2
Pittsburgh Equitable Meter Co. Front Cover
Prest-O-Lite Company, Inc., The 47
Price-Trawick, Inc. 92

R

Reed Roller Bit Company
Republic Steel Corporation 41-42

S

South Chester Tube Co.
Southwestern Gas & Electric Co.
Sperry-Sun Well Surveying Co. 91

T

Thermoid Rubber Co. 62
Tretolite Company Inside Front Cover
Trimont Mfg. Co.
Twin Disc Clutch Co. 65

U

Union Carbide & Carbon Corp. 47
Union Carbide Sales Company 47
United States Rubber Co. 17
Union Wire Rope Corp. Inside Back Cover

W

Waukesha Motor Co.
Wickwire Spencer Steel Company 54

Y

Youngstown Sheet & Tube Co. 60